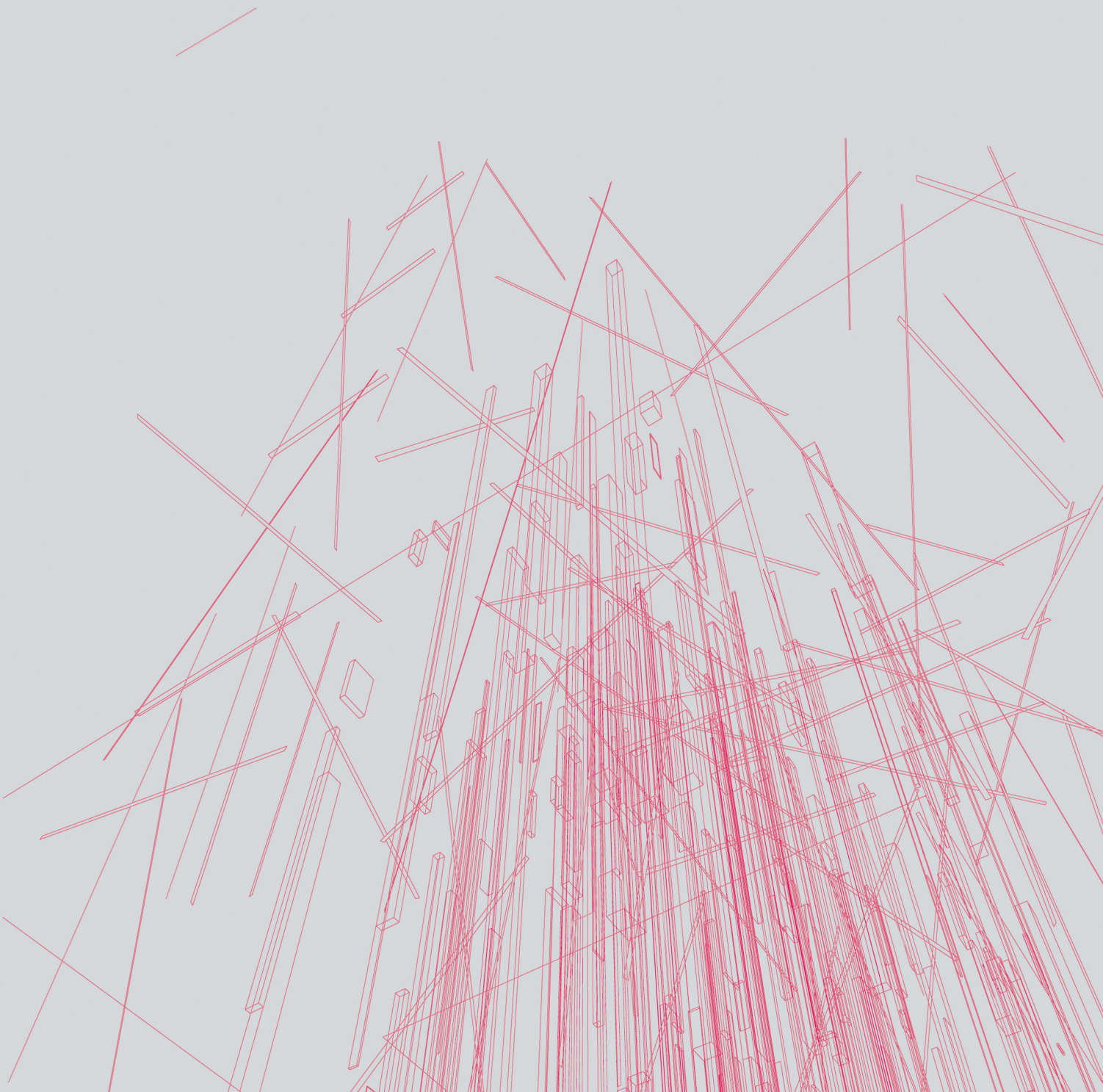




WHITE PAPERS | 01 | BIM





# INVESTING IN BIM: A GUIDE FOR ARCHITECTS





# INDEX

## 00 01 FOREWORD BY PAUL MORRELL

- 00 1.1 Learning to embrace change
- 00 1.2 The advantages of being small
- 00 1.3 Redefining the architect's role

## 00 02 CUTTING THROUGH THE BIM WASH

- 00 2.1. Clarifying confusion
- 00 2.2. What is bim?
- 00 2.3. Bridging the information gap
- 00 1.4 Getting the software right
- 00 1.5 Appreciating the benefits

## 00 03 THE BUSINESS BENEFITS OF ADOPTING BIM

- 00 3.1 Bim and the smaller practice
- 00 3.2 Why adopt bim?
- 00 3.3 Making architecture more enjoyable
- 00 3.4 Level 1 bim: greater effectiveness within the practice
- 00 3.5 Winning work through better visualisations
- 00 3.6 Collaborating with other practices
- 00 3.7 Sustainability
- 00 3.8 Making the commitment

## 00 04 THE TAKE UP OF BIM: THE RESULTS OF THE FIRST BD BIM SURVEY

- 00 4.1 Bim awareness levels
- 00 4.2 Comparison with NBS 2011 report
- 00 4.3 Journey towards bim
- 00 4.4 Levels of collaboration
- 00 4.5 Perceived benefits
- 00 4.6 Hunger for guidance

## 00 05 WHY THE GOVERNMENT IS BACKING BIM

- 00 5.1 What does the government want?
- 00 5.2 A change from past initiatives
- 00 5.3 How the government defines bim levels
- 00 5.4 COBie and its implementation
- 00 5.5 Meeting the 2016 deadline
- 00 5.6 Establishing bim hubs
- 00 5.7 Project liability and insurance

## 00 06 EXTENT OF THE ARCHITECT'S LIABILITY ON A BIM PROJECT

- 00 6.1 Collaboration and risk
- 00 6.2 Making sure you are protected
- 00 6.3 Joint and severable liability
- 00 6.4 Absence of case law
- 00 6.5 Intellectual property
- 00 6.6 Ownership of the model

## 00 07 INSURANCE FOR WORKING WITH BIM

- 00 7.1 The insurer's point of view
- 00 7.2 Evolving insurance products
- 00 7.3 Integrated project insurance
- 00 7.4 Encouraging collaboration

## 00 08 CHOOSING BIM SOFTWARE

- 00 8.1 Work out what is right for you
- 00 8.2 Small practices
- 00 8.3 Appraise your present position
- 00 8.4 Tools for sharing
- 00 8.5 Quizzing the vendor
- 00 8.6 Hardware upgrades
- 00 8.7 Vendor support
- 00 8.8 The importance of training
- 00 8.9 Custom training

## 00 09 BIM STANDARDS AND REGULATION

- 00 9.1 Increasing regulation
- 00 9.2 Extending the standards
- 00 9.3 The RIBA plan of work
- 00 9.4 Classification systems

## 00 10 BIM STANDARDS AROUND THE WORLD

- 00 10.1 Diverse approaches
- 00 10.2 The United States
- 00 10.3 Singapore
- 00 10.4 Northern Europe

## 00 11 ARCHITECT CASE STUDIES

- 00 11.1 The early adopter - KSS
- 00 11.2 The downsizing practice - NC Architects
- 00 11.3 The green architect - Architype
- 00 11.4 The disappointed user - St Ann's Gate
- 00 11.5 The accidental user - David Miller Architects
- 00 11.6 The collaborative architect - HLM
- 00 11.7 The big investor - Capita Symonds
- 00 11.8 The small practice - Axis Design
- 00 11.9 The sole practitioner - Emily Greeves Architects
- 00 11.10 The architectural technologist - WM Design & Architecture

## 00 12 CLIENT CASE STUDIES

- 00 12.1 Manchester City Council
- 00 12.2 Great Portland Estates

## 00 13 CONTRACTOR CASE STUDIES

- 00 13.1 Kier
- 00 13.2 Skanska

## APPENDIX

- 00 **i** Related articles from BD
- 00 **i.i** How will investing in bim affect your tax bill?
- 00 **i.ii** How to avoid the problems with bim
- 00 **i.iii** Bim adds an extra dimension
- 00 **ii** Related articles from Building
- 00 **ii.i** Bim and legal issues: Model behaviour
- 00 **ii.ii** The rise of the bim consultant
- 00 **ii.iii** Bim and the QS: Better late than never
- 00 **iii** Resources

## INTRODUCTION BY PAUL MORRELL

CHIEF CONSTRUCTION ADVISOR



## 1.1 LEARNING TO EMBRACE CHANGE

Not many people get up in the morning and say “I hope everything changes today”. It is therefore no surprise that, for all the excitement that the advent of bim has caused, the welcome from some quarters has been more muted.

I think this is actually a good thing. The natural history of new technologies shows that even those that survive to widespread adoption go through a cycle of hype, then disillusionment, then into a downturn which for some will become the valley of death, before interest picks up again for the lucky ones.

Those who have high hopes of bim would therefore do well to help it through this journey, smoothing out the hype and addressing early the potential sources of disillusionment.

These will vary. Some will have excessive hopes of the technology in the first place, either in terms of the benefits it might bring or the speed at which they might arrive. As one still-committed major client of the industry described it to me recently, it is like a permanent Christmas Eve: Christmas morning with its gifts never quite arrives.

At the other extreme are those who still don't quite understand what bim is (“We've been doing it for years”); and those who understand very well what it is, and are fearful of the change it might bring. Some of this is simply misdirected - like the suggestion that bim will kill the creative spark. A creative spark that can so easily be extinguished must have been very dim indeed.

## 1.2 THE ADVANTAGES OF BEING SMALL

Perhaps the most oft-expressed reservation about bim, however, is its potential cost - particularly for SMEs. In response to that, it is worth recording one of my favourite moments of the last year or so. At a roundtable organised at the RIBA, the head of technology for one of our major practices was listing the challenges of adopting bim, and was making it sound like very heavy weather, when the representative of a small practice interjected: “Anything you can't cope with, just send it to us.”

The fact is that what they may lack in depth of resources, small practices can make up in agility. They do not have deeply embedded legacy systems to uproot, nor a host of people to retrain. They can simply choose their course and be off on a new tack before a supertanker practice has even started its turn.

## 1.3 REDEFINING THE ARCHITECT'S ROLE

What this illustrates is that the future of bim will not be determined by territorial claims on the part of the professions or their institutions, based on some historical understanding of how the world should be ordered.

Instead, it will be about what individual businesses choose to be. For architects this brings to a head questions of identity and purpose that have preoccupied them for years. Simultaneously, however, bim provides them with the means of implementing those choices, whatever they might be.

So, master builders? Or masters of style? Or space? Or the universe? All of these choices and many in between are possible. What the evolution of bim will demand, though, is that the choice be made.

## SEEING THROUGH THE BIMWASH



## 2.1 CLARIFYING CONFUSION

Everyone in the process of adopting bim is moving forward at different speeds.

This is partly because practices that decide to engage with bim may be confused by the claims and counterclaims that are being made.

It is in response to this that BD's white paper on bim has been produced with the guidance of an editorial board, comprising four of the most expert practitioners using bim: Shaun Farrell, head of bim at Zaha Hadid Architects; David Light, associate and bim manager at HOK; Robert Jackson, associate at Bond Bryan Architects; and Robert Klaschka, founder of Studio Klaschka. It has been edited by architecture journalist and author Ruth Slavid and BD's technology editor Anna Winston.

From the outset it was agreed we needed to explain what we mean when we talk about bim. Even those appointed to educate others don't always understand themselves what bim is about. They are falling into the trap of over-promising – creating the notion of “bimwash”, in much the same way “greenwash” preceded it.

## 2.2 WHAT IS BIM?

Bim is not a box of software. It's a process, underpinned by new technology and collaborative working. It's about creating one location where all data pertaining to the project lives.

It includes not just design and construction, but also the operation, maintenance and eventual decommissioning of the project. It covers not just geometry but also the underlying information tied to the use and experience of that building.

Bim requires everybody to commit to adding to the model process to allow data to be shared for many purposes. Information helps the design team make better informed decisions, de-risking & ensuring a better quality end product.

## 2.3 BRIDGING THE INFORMATION GAP

In many ways it's the “i” in bim which is the most important factor. Certainly bim can bridge the information loss associated with handing a project from design team, to construction team and to building owner/operator, by allowing each team to add to and reference back to all information they acquire during their period of contribution to the building information model process.

Bim is able to achieve such improvements by modelling representations of the actual parts and components being used to design and construct a building.

For this to work, everybody must commit to adding to the model process to allow data to be shared for many purposes. Information helps the design team make better informed decisions, derisking and ensuring a better quality end product.

## 2.4 GETTING THE SOFTWARE RIGHT

“Bimwash” doesn’t only come from consultants but also from software companies. Architects must realise that they have options. There are multiple solutions available and practices should always try before they buy.

There’s no doubt time and commitment are involved in adopting what’s fundamentally a different approach to how the industry approaches design and construction. It’s not learning to use the software that’s the hard bit but mastering and finding the most efficient workflow that takes the time.

## 2.5 APPRECIATING THE BENEFITS

Architects who make these efforts should find that their practices are more effective, and that they enjoy better relationships with other consultants and with contractors.

These benefits are in addition to the external reasons for either deciding to adopt bim or deciding to extend a currently restricted use – that increasingly intelligent clients are asking for it, and that government is making it mandatory on its buildings.

The process of becoming bim-savvy can be daunting, but it is worth it. We hope this publication will make it a little easier.

## THE BUSINESS BENEFITS OF ADOPTING BIM



### 3.1 BIM AND THE SMALLER PRACTICE

It is difficult now to talk about architecture and construction without talking about bim. But the fact that it has become a buzzword, and that enthusiasts are proselytising for it on every possible occasion, doesn't make it any less daunting for those who have not yet engaged with the subject.

There are still many smaller practices that until recently either believed that bim was not for them, or at least that they could continue to ignore it for some time because it had no relevance to their work.

For many the wake-up call came when the government announced, in a document published last year, that design and construction of all government buildings would have to use bim by 2016. In terms of the business case for using bim, the one strong argument in its favour is that adopting it is necessary if a practice is not to miss out on working on buildings procured by the public sector.

And since this will affect all buildings within the sector, including smaller individual projects on new or existing buildings, bim is relevant to practices of every size.

### 3.2 WHY ADOPT BIM?

Will small practices really benefit, however? Employing bim involves investment in hardware and training, and it is important to understand that it will be worthwhile. While the messages mainly come from the enthusiasts, they are worth listening to. And it is also worth listening to some of their advice on how to get from "here" to "there".

On the other hand, there is the fear that some practices may have been left so far behind that they will never catch up. This is not true, as many practices are "talking up" their commitment to bim and the level at which they are using it.

It is not too late now, and the catch-up will not be as frightening as many believe — but if they ignore the issue now, then in a few years some architects could find that they really have been left behind.

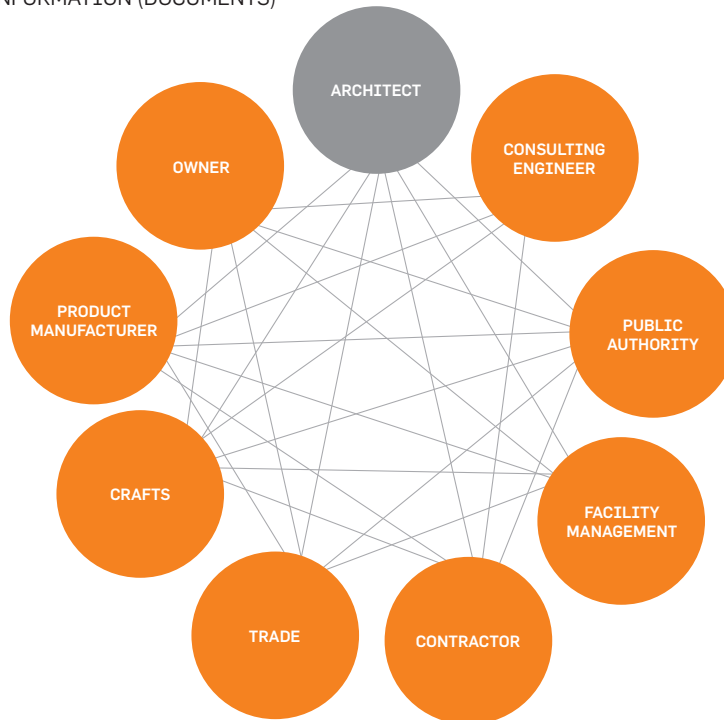
In addition to ensuring that a practice is still eligible to do work on government-funded buildings, there are other strong arguments in favour of bim. It should enable better, more imaginative and more effective design. Construction should be a smoother process and unexpected clashes and problems should be eliminated, allowing the building to be constructed as designed, without any ugly workarounds necessitated by unexpected clashes on site.

Respondents to BD's survey (see section 4) were asked to list the main advantages of bim. Their responses included: "The opportunity for collaboration in a less adversarial environment"; "Co-ordination and natural thinking process"; "That it will enable us to deliver better buildings — time saved in mundane tasks can be invested in the design".

Nearly half of all practices responding (49%) said that their experience with bim so far had been worth the investment they had put in. Only 8.5% said that it had not, with the rest saying that it was too early to tell.

### TRADITIONAL FLOW OF INFORMATION (DOCUMENTS)

Trying to keep all parties in the loop on a project has become increasingly complicated



### A SHARED INFORMATION MODEL

Bim standards simplify the process with all parties working from one central 'source of truth'



### 3.3 MAKING ARCHITECTURE MORE ENJOYABLE

In terms of the architect's office, it should be possible to do more with fewer people, not because design will become a mechanised process, but because the repetitive elements will be eliminated. In other words, there would not only be a business case in terms of making more money and winning more work, but architecture should actually become more enjoyable.

This argument may come as a surprise to some, who see bim as the imposition of another set of protocols, another computer system that takes away the freedom and creativity of the architect. The important thing to remember is that it is just a tool, and in fact it is a tool that operates in the way in which good architects think.

There are many different ways of describing bim, but one of the simplest is to say that it is three-dimensional design, with information attached to a greater or lesser degree to the elements of the design.

By creating a 3D model, an architect is modelling in the way that they think. Plans and sections, the outputs with which everybody is familiar, are simply a way of communicating the design. They are not design itself. In bim talk they are "deliverables".

It is unlikely that they will disappear for a long time, if at all. But if architects start thinking of them in this way, then the changes in approach and protocols that bim does demand become far more acceptable. They are a way of leading designers towards a more natural way of designing.

Once an architect can start attaching information to a model, life becomes much simpler. If, for example, a designer defines a door



electronically they can use that door several times in the building, without having to enter the information again. They can change the form of the building but keep the doors the same. Or they can change one of the doors and all the other doors will change as well.

### 3.4 LEVEL 1 BIM: GREATER EFFECTIVENESS WITHIN THE PRACTICE

This has two important implications. One is that there is more room to experiment, and so architects can be more creative. The other is that the tedious but previously essential elements of projects — such as endless door schedules — are no longer necessary. This means that bim is getting rid of work that nobody enjoys or wants to do. The practice is becoming more effective.

This can however have implications for the way that a practice is run. Robert Klaschka, who is one of the pioneers of bim and runs his own small practice, Studio Klaschka, in which he says he now struggles to find work suitable for a year-out student, says: "Big practices have the wrong staff demographics. They still have professionals with a team of draughtspeople. Bim fills all the traditional gaps that were filled with technicians."

Rob Jackson, who is in charge of bim at architect Bond Bryan, says: "We are eliminating mundane tasks. It eliminates the boring bits. We have been doing bim for seven years. If we asked our staff if they would go back to 2D they would laugh at you."

When making changes to a design, bim should mean that errors are reduced. Jackson adds: "I believe our buildings are better, better co-ordinated, better delivered."

Jonathan Lock, who runs a bim operation within engineering practice Arup, says: "If you put this co-ordination in place, you will reduce clashes, reduce wastage, reduce CO2 output and improve health and safety."

This is true even for the work that goes on within a practice, without any collaboration with other members of the design team, or with the contractor. This approach of working solely within the practice is, roughly speaking, what is defined as Level 1 bim.

If none of this sounds terribly new, it is because 3D design packages have been around for a number of years, and it has been possible to append information to them for almost as long. But people have either not been doing it, or have not been doing it properly.

Many practices may find they are well on the road to employing bim already. Lock says: "A lot of architects do the model to get through planning. But once they have created the drawings the danger is if they decided not to keep model up to date. They export it to 2D and carry on from there."

Any practice that has the software, and has at least some idea of how to use it, is already ahead of where it could have been. The team will probably need more training, and will certainly need a change in attitude.

In particular, on the projects where the practice is going to use bim, it will need to be utterly disciplined in keeping the 3D model up to date. All too often, what happens after the planning stage is that either the 3D model is abandoned altogether, or alterations are quickly made on 2D drawings and are not transferred to the model, so that its integrity is lost. Having the discipline not to do that is essential for the successful deployment of bim.

### 3.5 WINNING WORK THROUGH BETTER VISUALISATIONS

Bim can also help in winning work. This is because of the ease of producing visualisations, which will give clients a real appreciation of what the architect is proposing. This can be as easy as plugging into visualisation software and producing a rendering that has very little hard information behind it but gives a strong impression of what has been proposed. For example, Klaschka has visualisations on the wall of his office that he says required remarkably little work to produce.

Even more exciting, information from building information models can be used to create virtual environments by feeding it into technology known as Cave. A Cave is a space in which projections can be made onto the walls and the floor. Visitors, equipped with 3D glasses, can experience it as a real space.

HOK has used the Cave facility at Reading University for some of its healthcare work, testing not only patient rooms but also lines of sight from the nursing station. This gives clients a much better sense of what is proposed than other visualisations would do.

It is possible to offer a range of options, whereas a full-scale mock-up would offer only one option. And although it is not cheap, it is less costly than creating several physical mock-ups. David Light of HOK says: "It could make the difference between winning and losing the job."

### 3.6 COLLABORATING WITH OTHER PRACTICES

Once an architect starts to collaborate with other practices, which is roughly speaking what Level 2 bim means, there will be further advantages. This does not mean that everybody will be working on a "single building model" which is the Holy Grail of Level 3 bim, and one that many people believe will never come.

Information will be exported to other packages and brought back in. Exchanging information when everybody is working with different software will have some glitches, but will be by no means impossible.

There will need to be somebody to co-ordinate all this work. At present some ambitious projects are using outside bim co-ordinators, but eventually this person should definitely be within the architect's practice. And, with time, the role of bim co-ordinator will probably meld with that of project architect. Taking on this responsibility will help architects to strengthen their role at the heart of the design process.

### 3.7 SUSTAINABILITY

Another of the potential big wins is on sustainability. The way that any decision made about a building affects its sustainability is highly complex. For example, if one introduces higher ceilings to allow stratification of air and night purging, this will make the building taller, and so increase the volume of materials used and hence the embodied energy.

Is this a good idea or not? Because of the complexity of decision-making, feeding the correct algorithms in for use with a building information model is far more complex than, for instance, dealing with changes in structural terms.

Klaschka, for example, says: “The interesting things from the designers’ perspective come before the construction information. Everyone can for example export to an energy model.” But he is also sceptical about the sustainability information that is currently available. “Out of box data sets are not that good. Up to now we have thrown them away and authored them ourselves.”

But there is also tremendous hope for the future. Speaking at a recent event, Gary Newman of the Association of Sustainable Building Products said: “With bim we can really engage with resource efficiency and responsible use of materials. We can really understand the inputs we are making.”



### INVESTMENT VERSUS RETURN

The value proposition of BIM is often misunderstood by clients - this diagram, based on a concept by Jacob Mehus of Standards Norway originally presented at a BuildingSmart event, graphically demonstrates where the real returns are for clients.



### 3.8 MAKING THE COMMITMENT

Even with all these advantages, deciding to commit to bim may still be daunting. But it shouldn't be. Practices may, as discussed above, already be partway there. And if they are not, the consensus is that it is actually easier for a smaller practice to adopt bim.

True, they are unlikely to have the luxury of a dedicated bim manager. But neither will they have the necessarily cumbersome practices and ways of working of a big practice. Bim requires change, and small practices are more agile. David Light of HOK says: "A smaller practice will be more nimble. If a big practice makes a commitment it makes life easier for everybody. But it is like moving a cruise liner."

Advantages start to accrue early in the bim process, so a step-by-step approach is practical. It is best to start with a single project, and probably not the most complex or demanding.

Somebody needs to champion the idea of bim within the practice, and the practice needs to be prepared to set up new systems and import information. But it will have the consolation of knowing that it is not an early adopter. Numerous user groups are being set up around the country, some of them around specific software packages, others entirely independent. They will deal with everything from arcane questions to beginners' nerves.

Not everything works perfectly yet, but it is in the interest of software developers to make improvements. Now is a good time to take the plunge.

## THE TAKE-UP OF BIM: SURVEY AND ANALYSIS



#### 4.1 BIM AWARENESS LEVELS

There is still a lot of learning to be done about bim, according to a survey of readers of Building Design.

Half of the profession does not know what the three levels of bim are. Asked if they understood what was meant by Level 1 bim, Level 2 bim and Level 3 bim as defined by government, 184 out of 369 respondents (49.9%) replied “None of the above”. A further 118 respondents skipped the question, suggesting that there were many among them who did not know how to answer (Table 1). And 54.6% of respondents do not know what COBie is, the format in which the government wants all practices to supply information by 2016 (Table 2).

On the other hand, the sole practitioner who admitted “I hadn’t heard of bim until today” was in a minority. Only 14% of those who replied to the survey were not engaging with bim at all. Another 20% were investigating the business case, and with the exception of a few who were not currently working within an architect’s practice, everybody else was on the route to using bim, even if they had not actually carried out any projects yet (Table 3).

One respondent from a large practice (more than 50 architects) summarised a general feeling by writing: “Practices that choose not to adopt are burying their heads in the sand and will find their competitiveness is eroded by competitors who can deliver leaner, more cost effective services.”

Sole practitioners not surprisingly were less engaged with bim, with 28.8% not using it at all, and a further 27.1% “investigating the business case”. Only a handful use bim in any meaningful way. The results were broadly similar for practices with fewer than six architects, where half of respondents were either not using bim at all or investigating the business case.

As the practices grow so does the engagement with bim. There were no practices between 25 and 40 architects that had not engaged with bim at all, and only three of the largest practices. Among those largest practices, more than half used a bim workflow to exchange information with other consultants and contractors, either in the form of a building information model or by sharing information from the model.

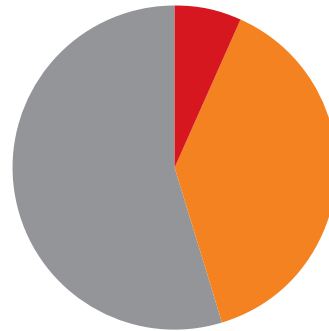
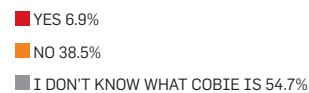
TABLE 1

DO YOU UNDERSTAND THE GOVERNMENT’S DEFINITION OF:



TABLE 2

HAVE YOU USED COBIE ON ANY OF YOUR PROJECTS?



#### 4.2 COMPARISON WITH NBS 2011 REPORT

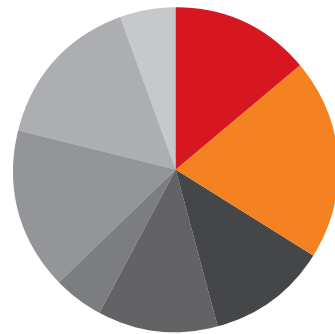
This makes an interesting contrast with the NBS report on bim carried out in October and November 2011, less than six months ago. Some 31% of respondents to that said they were “aware and currently using bim” (around 47% of the BD respondents could be said to be currently using bim, and most of the other respondents would be classed as “aware”). Another 48% said they were “just aware of bim”, while 21% were neither aware nor using bim. These figures themselves showed an increase in awareness compared to a similar study that NBS carried out a year previously, but BD’s survey shows another step forward in awareness and willingness to engage.

One must be aware that while BD’s respondents are predominantly architects, those replying to the NBS survey were, in principle, drawn from across the construction industry. But in fact, architecture dominates, with 37% of the NBS respondents being architects, and a further 21% being architectural technologists.

“WE DON'T WORK WITH MANY PEOPLE WHO USE BIM. EVERYONE SEEMS TO STILL PREFER 2D. ESPECIALLY CONTRACTORS!”

TABLE 3

WHAT MOVE TOWARDS BIM ADOPTION HAVE BEEN MADE IN YOUR PRACTICE?



■	NONE – 14%
■	WE ARE INVESTIGATING THE BUSINESS CASE – 20%
■	WE HAVE INVESTED IN SOFTWARE AND STAFF TRAINING BUT HAVEN'T TRIED TO USE A BIM WORKFLOW ON A PROJECT YET – 11.9%
■	WE HAVE TRIED BIM ON AT LEAST ONE PROJECT BUT HAVE NOT SHARED THE MODEL OR DATA WITH ENGINEERS OR CONTRACTORS – 12.1 %
■	WE USE A BIM WORKFLOW ON MOST OF OUR PROJECTS BUT DO NOT SHARE THE MODELS OR DATA WITH ENGINEERS OR CONTRACTORS – 4.8%
■	WE HAVE USED A BIM WORKFLOW TO SHARE MODELS OR DATA WITH ENGINEERS OR CONTRACTORS AND OTHER CONSULTANTS – 16.2%
■	WE REGULARLY USE A BIM WORKFLOW TO EXCHANGE MODELS WITH ENGINEERS AND CONTRACTORS – 15.7%
■	OTHER – 5.3%

### 4.3 JOURNEY TOWARDS BIM

BD's survey looks in far more detail at aspects of using bim, and the responses are encouraging for those who are still at an early stage on the journey. Nearly half of respondents using bim found that the experience so far has been worthwhile (Table 4), with another 42.6% saying that it was too early to tell. And 85% of respondents are planning to invest further in bim in the next two to five years (Table 5).

Practices are still very much in a state of transition to bim and 3D design. Nearly half of respondents are still doing over 60% of their work in 2D (Table 6). In response to a question asking all those doing over 20% of their work in 2D why this was, some respondents felt that it was down to lack of investment: "A combination of not enough staff training and investment in software licences" (from an architect in a practice with fewer than 25 architects).

Others were still in the process of rolling out bim across the practice, and still others felt that it was not applicable to the sort of work that they were doing: "We are a small practice, mainly carrying out refurbishment work and we do not feel bim would be good value for money for our type of work."

Some simply could not see the point and were despondent, like the architect from a practice with fewer than 15 architects who said: "Lack of reliable software, Lack of training, 2D more than adequate for most purposes. Economics of changing to bim (software acquisition, training, familiarisation period would be extensive)".

But others were grasping the possibilities. An architect from a practice with fewer than 40 architects wrote: "We are just starting the implementation of Revit and making the translation from AutoCAD drawings to Revit models. We are beginning to understand the possibilities of the software."

TABLE 4

HAS YOUR EXPERIENCE WITH BIM THUS FAR BEEN WORTH THE INVESTMENT YOU'VE PUT INTO IT?

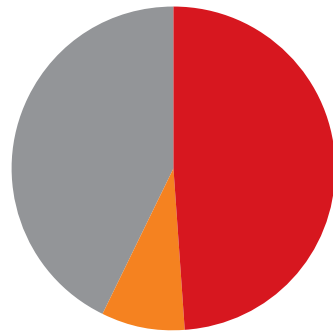
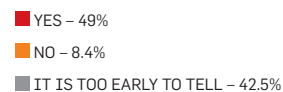
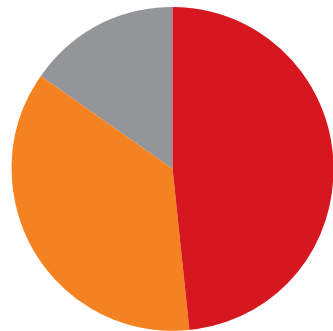
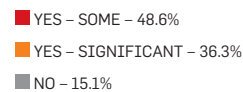


TABLE 5

ARE YOU PLANNING ON MAKING ANY FURTHER INVESTMENT IN BIM IN THE NEXT TWO TO FIVE YEARS?



#### 4.4 LEVELS OF COLLABORATION

Of the practices using bim, the level of collaboration with other disciplines is high (Table 11). Some 18.4% are only using bim at Level 1, which means that they are using it without any collaboration, but most are in the process of adopting Level 2 bim, collaborating with others. It is interesting to see, since most experts believe that Level 3 bim, with full integration, is not available yet, that 18 respondents claim to be using it. A degree of wishful thinking, perhaps?

The most common collaborations in terms of exchanging bim models are with structural engineers (42.7%), followed by services engineers and then contractors (Table 9), and the figures are broadly similar when it comes to exchanging data (Table 7).

“THE MODEL HAS  
BECOME THE CENTRE  
OF ALL ACTIVITIES,  
BINDING THE TEAM  
TOGETHER TO WORK  
TOWARDS A COMMON  
GOAL”

TABLE 6

WHAT PERCENTAGE OF YOUR WORK IS STILL DONE IN 2D?

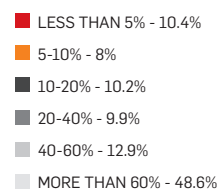
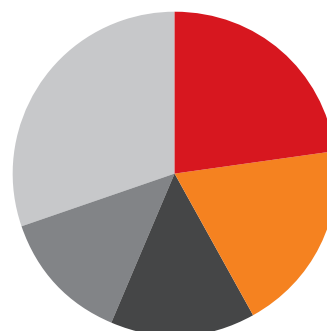
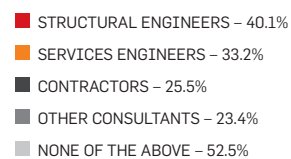


TABLE 7

DO YOU COLLABORATE BY EXCHANGING DATA PRODUCED FROM A BIM WORKFLOW WITH:



#### 4.5 PERCEIVED BENEFITS

So what are the advantages? The most significant is that it enables better collaboration, with 26.2% of respondents seeing it as the main benefit, and a further 36.1% considering it significant (Table 8). Making analysis of projects easier, and making concepts easier to realise, were next in popularity, followed by reduction of waste, where more than half of respondents thought it was at least significant enough to be worthwhile.

Reducing costs were the least important benefits, and 28.5% of respondents thought that “reducing costs for us” was definitely not a benefit. This may reflect the investment in software and training, coupled with the fact that, while still learning to use bim, efficiency is likely to go down not up.

When asked to suggest other benefits, these centred on either improving the service that the architect could offer, such as “Speed of information availability” and “Quicker to assess sustainability objectives and energy (including embodied energy)”, or on advancing relationships and collaboration both within and beyond the practice.

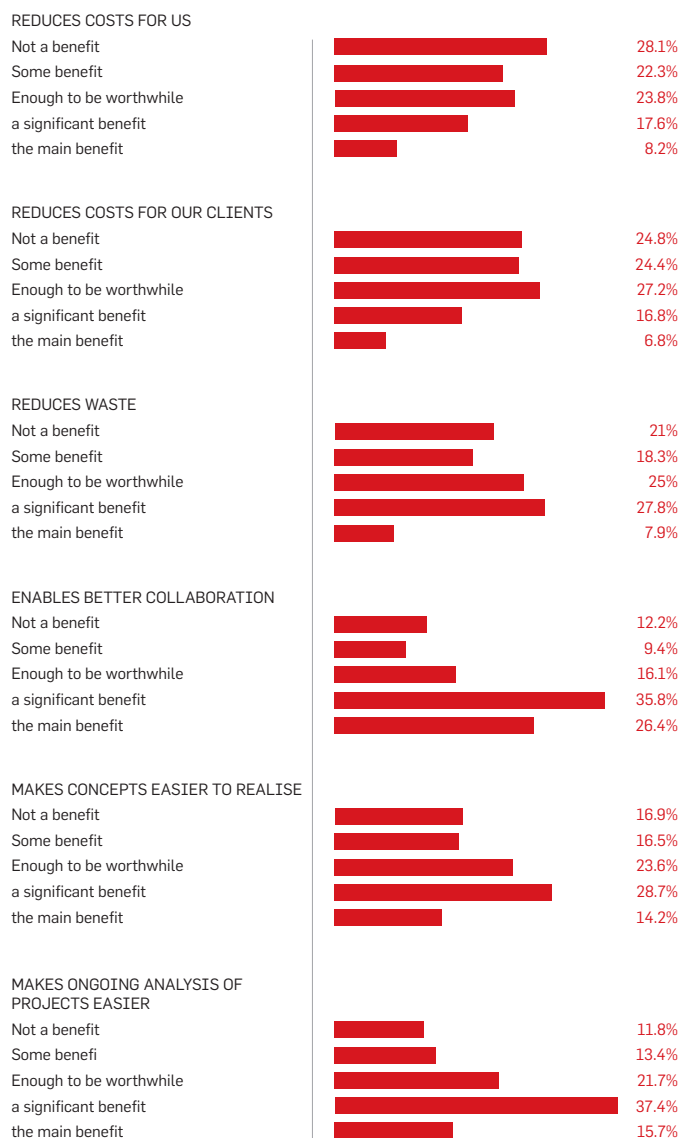
These responses included: “Really brings teams together, moves design input left in the RIBA design stages, forces resolution to problems earlier and better communication, helps reduce blame culture”, and “excellent communication with clients and key stakeholders. You can show the building and context rather than codified line drawings.”

The most exciting results are those where architects are grasping opportunities. Just over two-fifths of those using bim (41.5%) have been asked to provide bim co-ordination on a project (Table 9), and four-fifths believe that this is a role that architects should fulfil (Table 12). Typical responses include “Because they have the right mindset to take the overall view of the project and its data”.

Those who do not want to take on the role seem to see it just as extra work, such as this respondent: “Architects already have too much on their plate – I think an outsider appointed project manager should wear the hat.”

TABLE 8

#### WHAT HAVE YOU FOUND TO BE THE MAIN BENEFITS OF BIM?



#### 4.6 HUNGER FOR GUIDANCE

Most respondents, though, are looking for opportunities rather than problems. Some 73.2% want to sell additional bim services, and 78.7% think that bim will provide an opportunity for architects to become more involved in facilities and asset management.

Asked about selling additional bim services, responses involved playing a stronger role with clients and contractors, such as this from an architect in a large practice: “Clients and contractors are eager to learn about bim but don’t know how to start accessing it – architectural practices are well placed to offer this additional training service.”

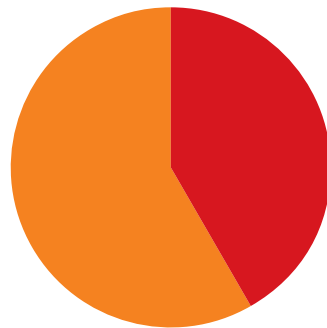
There is definitely a hunger for more guidance. Only a quarter of respondents thought that the RIBA was providing enough guidance (Table 10) and less than a third thought the government was doing enough (Table 13).

Richard Brindley, executive director for membership and professional support at the RIBA, says that in fact the RIBA is running CPD seminars aimed at a variety of levels, as well as providing written information through RIBA Enterprises and NBS. But, he adds: “I am not surprised by this response. For some people RIBA can never do enough. But we also have a communications problem with members, which means that they may not know what we are doing. We are doing a big communications review at the moment.”

TABLE 9

HAS YOUR PRACTICE BEEN ASKED TO PROVIDE BIM CO-ORDINATION ON A PROJECT?

■ YES – 41.8%  
■ NO – 58.2%



“I FEEL THAT ARCHITECTS ARE BEST PLACED AS LEAD DESIGNERS WHO ALREADY COORDINATE PROJECT INFORMATION. ARCHITECTS UNDERSTAND THE DIFFERENCE BETWEEN CO-ORDINATION AND CLASH-DETECTION.”

Asked where else they went for help, architects are obviously eager for advice. Informal sources included peer groups, online forums, and twitter. Both NBS and the American Institute of Architects were mentioned several times.

Both software houses and resellers were mentioned, although with warnings that they could be very partisan. Seminars, webinars, the press and magazines (with several mentions of BD) were popular, as were regional user groups.

Some of these will be more reliable than others, and the wide range of responses is an indication that there is no single reliable source. Architects are, in general, ready to engage with bim in a more intense way. But they would really like some help.

TABLE 10

IS THERE ENOUGH GUIDANCE AVAILABLE FOR ARCHITECTS LOOKING AT BIM ADOPTION FROM THE RIBA?

■ YES – 25.7%  
■ NO – 74.3%

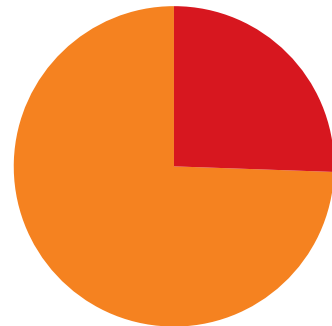


TABLE 11

HAS YOUR PRACTICE IMPLEMENTED:

■ LEVEL 1 BIM – 18.3%  
■ LEVEL 2 BIM BEGINNER (JUST STARTING) – 21.8%  
■ LEVEL 2 BIM INTERMEDIATE (HAVE BEEN USING SOME ELEMENTS FOR A WHILE) – 26.6%  
■ LEVEL 2 ADVANCED (FULLY IMPLEMENTED) – 11%  
■ LEVEL 3 – 4.8%  
■ NONE OF THE ABOVE – 43.5%



**This piece discusses the results of a survey carried out by Building Design in April 2012.** There were a total of 500 responses.

"I'VE HAD THE HOPE THAT BIM CAN PLAY A SIGNIFICANT ROLE IN THE EVOLUTION OF ARCHITECTS — NOT ONLY AS DESIGNERS BUT TO GET THEIR HAND BACK INTO MANAGEMENT."

---

TABLE 12

DO YOU AGREE THAT ARCHITECTS SHOULD BE RESPONSIBLE FOR BIM CO-ORDINATION ON CONSTRUCTION PROJECTS?

■ YES – 80.1%  
■ NO – 19.9%

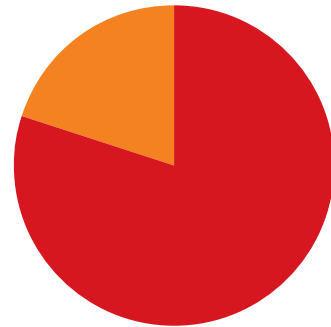
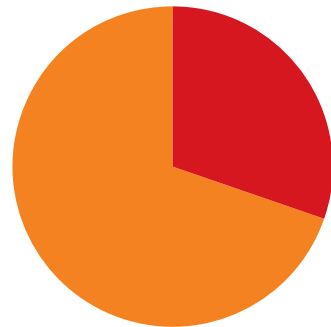


TABLE 13

IS THERE ENOUGH GUIDANCE AVAILABLE FOR ARCHITECTS LOOKING AT BIM ADOPTION FROM THE GOVERNMENT?

■ YES – 30.5%  
■ NO – 69.5%



## WHY THE GOVERNMENT IS BACKING BIM



## 5.1 WHAT DOES THE GOVERNMENT WANT?

The first important thing to understand about the government's approach to bim is that the benefits that it is seeking are not the same as those that an individual architect's practice would look for.

This is not to say that they are aims that are hostile to architects' wellbeing, but that the government is looking for different outcomes. It is looking for improvements to the built environment in terms of the cost and the environmental performance of buildings. If these make life easier for architects or improve their competitiveness, all well and good — but this will be an incidental benefit, not a core aim.

The government's ambition is a big one. Under the auspices of Paul Morrell, its chief construction adviser, it wants to transform the UK construction industry, to make it more efficient and to make it greener. The clue was in the title of the document that the UK government's bim group, chaired by Mark Bew, produced last year: *Bim Management for Value, Cost and Carbon Improvement*.

Put crudely, government sees bim as a way of ensuring collaboration, one of the bugbears of the construction industry, and of building a body of reproducible knowledge. Furthermore, it sees the information that bim generates having a use throughout the life of the building, as it should help building owners and facility managers to better understand and manage their buildings and the subsequent changes and development to those buildings.

## 5.2 A CHANGE FROM PAST INITIATIVES

There have been previous attempts, in the form of big reports, to improve the operation of the construction industry — for example, Sir Michael Latham's *Constructing the Team* report in 1994. These proposed radical reorganisations to the construction industry. Apart from seeming more interested in process than in outcomes (if buildings were delivered efficiently it didn't much matter what they looked like), they also raised the question of how we got from the "here" of current practice to the "there" of the supposedly ideal solution.

This time round the government is not asking the industry to organise itself in a specific different way. It is just asking it to provide certain types of information — a model in Level 2 bim, specific information in a form called COBie and further information in the form of 2D drawings as PDFs. How the industry does this is not government's concern. It is simply specifying outcomes, and allowing the industry to sort out how it wants to get there.

And this is not really intended as a way to make government buildings better, although that will be a desirable side effect. It is

simply that this is the area over which the government has control.

Its aim is to see this approach applied to all buildings — that once all members of the construction industry have learnt to work and collaborate in this way, they will continue to do so. And that once clients have seen the advantages, they will expect this as standard. It also believes that it is important for the British construction industry to do this if it is to remain competitive on the world stage.

In all the years that the construction industry has been breast-beating about its inefficiencies, it has constantly been asked to compare itself to the car industry and the aeronautics industry, where quality has been raised by controls that eliminated errors. The idea is that, with bim, the building can be modelled in all its detail before it is constructed and that feedback from the project can go into making the next project better.

In the past there has been a lot of talk about the fact that all buildings are different from each other whereas all cars, for example, are the same. But there is a growing understanding that buildings are not necessarily as different as we have thought, while manufacture is increasingly able to produce variants and one-offs, unlike the standardised production lines of the past.

So construction and other industries have come closer together, and there is far less of an excuse for construction to brand itself as special, and believe it can ignore the improvements that other industries are making.

### 5.3 HOW THE GOVERNMENT DEFINES BIM LEVELS

Government has created a definition of Level 2 bim, and the intention is that, by 2016, all projects should be delivered in Level 2, and we should be starting to progress to Level 3.

These are the levels as the government defines them:

- Level 0 - Unmanaged cad, probably 2D, with paper (or electronic paper), as the main exchange mechanism.
- Level 1 - Managed cad in 2 or 3D format, using BS1192: 2007 with a collaboration tool providing a common data environment, possibly some standard data structures and formats. Commercial data managed by standalone finance and cost management packages with no integration.
- Level 2 - Managed 3D environment held in separate discipline “bim” tools with attached data. Commercial data managed by an ERP. Integration on the basis of proprietary interfaces or bespoke



middleware could be regarded as “pbim” (proprietary). The approach may utilise 4D programme data and 5D cost elements as well as feed operational systems.

ⁿ Level 3 - Fully open process and data integration enabled by “web services” compliant with the emerging IFC/IFD standards, managed by a collaborative model server. Could be regarded as ibim or integrated bim potentially employing concurrent engineering processes.

#### 5.4 COBIE AND ITS IMPLEMENTATION

COBie is at the heart of the government’s approach to bim, and has been the subject of a great deal of angst. Standing for Construction Operations Building Information Exchange, it is a system for handing over data that was originally developed by NASA and the White House Office of Science and Technology Policy in 2006.

The government defines it as the “formal schema that helps organise information about new and existing facilities. It is general enough that it can be used to document both buildings and infrastructure assets. It is simple enough that it can be transmitted using a spreadsheet. It is means of sharing structured information, just like CDM and bim.”

It is, quite simply an Excel spreadsheet that contains all the information that is stipulated to be wanted at each stage of the project.

One of the strengths of COBie is that it does not require everybody to be using bim in order to supply the information. So although the project has to be produced in bim, certain parties – such as for example a small supplier of materials – can contribute their information by manually adding it.

There is some concern about the difficulty of actually exporting information to COBie from building information models. One might expect to simply press a button and output to COBie, but it is far more complicated than this, although the software companies are working to make this better. The information that COBie requires is wide ranging, and no one party can supply it all. Indeed, that may be one of its hidden strengths – to fill in the spreadsheet requires collaboration, the very thing the government is looking for.

Mark Stodgell, who runs the bim operation at architect Pozzoni, says: “This is a good example of light-touch government. It says we want this as a deliverable, but we will let the industry use its own way to get there. I don’t see COBie as a problem as a deliverable, but who is going to put the information in? It means we will have to take down a lot of barriers between organisations. Everybody should take those walls down.

#### 5.5 MEETING THE 2016 DEADLINE

Government has now produced its COBie 2012 standard, so the detail of what is required is available. This is needed because the first pilot projects in bim are going ahead. Indeed, while anyone with any sense would have realised that the date of 2016, by which the government wants all its projects to be in bim, is not far away, the reality is even scarier for the unprepared.

Each government department is moving at its own pace towards this end date. The Ministry of Justice is the furthest ahead, and plans to deliver all its new work using bim by 2013 – yes, next year! Other departments are at different levels of readiness, so one can expect them to come on stream in 2014 or 2015.

The projects that the Ministry of Justice is undertaking include one on a retained building. Since existing buildings will provide the majority of building work in the next two decades, a new method of approaching construction would be pretty valueless if it ignored this sector. With sophisticated laser surveying now available, it is relatively straightforward to gather the spatial information that one needs to feed into a model.

### 5.6 ESTABLISHING BIM HUBS

For government the introduction of bim is a vastly ambitious project, and it recognises the fact that it will be difficult for the industry to keep up. In order to help it is setting up a series of bim hubs around the country, which should be in place by the end of the year.

There will be at least nine of these and they will be physical places, rather than merely virtual. The easiest way to think of them is like Citizens Advice Bureaus for the bim user or potential bim user, although unlike the CABs they will not be sources of expertise in themselves but will largely point visitors in the direction of information and training.

### 5.7 PROJECT LIABILITY AND INSURANCE

There could not be a government initiative without advisers and subgroups and sub-committees beavering away, and the move towards bim is no exception. There is work to build understanding and knowledge in a wide range of areas. One of these is the vexed question of project liability and project insurance.

With Level 2 bim, there will not be a single seamless model, and so it should be possible to apportion blame and responsibility in the same way as under traditional ways of working. But this of course goes against the spirit of collaboration of bim. The first project being undertaken is being done with single project insurance, again an idea that has been around for a long time, although not often implemented.

There is the paradox that people are concerned to know what will happen when a project goes wrong, whereas with bim the whole ethos is that it should prevent things going wrong. Only the greatest optimist would believe that there will be no hiccups along the way, but government seems to be determined to make this work if it can. By consulting widely with the industry it is positioning itself as well as it can. And by proffering a big opportunity, it is also encouraging the software houses to develop in a way that can help this happen.

It would be a bold (or foolhardy) architect indeed who would say: “Bah, bim, it will never take off. Government will talk about it but it will never happen.”

# EXTENT OF THE ARCHITECT'S LIABILITY ON A BIM PROJECT

BY PATRICK PERRY AND LAURA COATES



## 6.1 COLLABORATION AND RISK

The use of bim on a construction project raises issues for every professional engaged to work on that project, including architects. It has been suggested that the use of bim could result in fewer risks for architects on the basis that they become aware of potential construction problems at an earlier stage of the design and build process.

However, the kind of collaboration envisaged within a bim system spreads the decision-making for design elements beyond the scope of architects. Architects should be aware that the liability for design errors and omissions may be heightened by a move away from the traditional separation of project functions to a more collaborative process.

Architects should also consider that over-reliance on bim technology could create the risk of heightened liability if information that has been input into a bim system is incorrect or if the software processes it incorrectly. There exists the risk that bim software contains flaws that will result in design defects beyond the control of the architect. Liability may also arise in connection with third parties such as sub-contractors on a bim project.

The concern has also been raised that contributing to or inputting into another professional's model could impose significant design responsibility. In *Co-operative Insurance Society Ltd v Henry Boot (Scotland) Limited* (2003) it was said that "someone who undertakes, on terms such as those of the contract...an obligation to complete a design begun by someone else agrees that the result, however much of the design work was done before the process of construction commenced, would be prepared with reasonable care and skill".

There are four levels of bim maturity, ranging from 0 to 3. Level 0 comprises two-dimensional drawings, typically shared in hard copy format. At Level 1, computer-aided design (CAD) is used to create 2D or 3D drawings. The data may be accessible to the construction team, but commercial data remains separate. By Level 2, the bim database could include information about costs and programming, but there is not one single database and commercial data is still held separately. At Level 3, all data would be contained in an integrated web-based system that is accessible to all members of the project team.

## 6.2 MAKING SURE YOU ARE PROTECTED

As the use of bim develops, architects have the opportunity to explore ways to protect themselves from increased liability when working on bim projects. They will want to ensure that the scope of protection provided by their professional liability insurance policies is sufficient to cover their professional appointments. While current policies may not expressly provide coverage for claims arising out of the use of bim, it is important that at a minimum such claims are not excluded.

Design professionals should also seek to ensure that contractual protection is afforded to them, through clear provisions setting out ownership rights and responsibilities. Clauses could be inserted to

expressly state that it is not intended that the standard of care applied to the architect's services is altered by the use of bim technology. Architects could also request that they are absolved from any liability where their work can be altered in the future by other parties.

To provide protection from failure of bim systems or errors in bim data for which they are not responsible, architects could insert into their contracts a waiver of direct or consequential loss arising from such failures or errors. The use of a bim protocol could also limit the liability of the architect to an extent consistent with his fees and available insurance.

### 6.3 JOINT AND SEVERAL LIABILITY

Under English law, there can often be onerous outcomes resulting from the principle of "joint and several liability". What this means is that where a claimant has suffered a loss resulting from the actions of a number of professionals, he can choose to pursue only one of them for the full extent of his losses, and leave it to that defendant to seek to claim back any losses from others.

This can present serious problems when one or more parties to a dispute becomes insolvent, or has inadequate insurance cover. In that situation, the architect could be left bearing 100% of the losses, even though he was realistically only, say, 20% to blame. The collaborative nature of bim does expose architects to this risk.

The two best risk management tools are, firstly, to ensure (if this is possible) that you are comfortable with the co-professionals involved; and secondly, to seek Net Contribution Clauses in the Appointment (as exist in RIBA Standard Forms). Such clauses expressly limit the architect's liability to the portion of the loss which reflects his actual culpability.

As the sophistication of bim increases, the complexity of a Level 3 building information model could make it harder to identify the party responsible for an error and to allocate liability to them accordingly. Where lines of responsibility are blurred in the collaborative process, the professional liability risks associated with the design of a project may spread further than is traditionally experienced.

The use of bim protocols could address the management of risk/liability at more integrated stages of the bim process. Also, for projects using more advanced bim levels, the availability of integrated project insurance could make liability less of an issue as the focus



shifts away from imposing liability on an individual contributor.

Collective single project insurance could support a more collaborative construction process and reinforce the “team approach” that the government’s construction strategy is working towards. While single project insurance has in the past been viewed as an expensive option, it would be well suited to a project where the risks are reduced due to the use of bim processes.

#### 6.4 ABSENCE OF CASE LAW

As yet there are no reported decisions relating to bim. Bim is still relatively new in the UK and there is no case law guidance as to the allocation of risk and liability on a bim project. The first US dispute to arise from the use of bim was settled outside court, with the contractor, architect and consultant on the project each contributing to the settlement.

We have been involved in a case which perhaps highlights the risks of increasing dependence on technology. Cad drawings were unfortunately “stretched” on the system, the result of which was that various housing blocks were, quite simply, built in the wrong place. As this was in contravention of planning, a stop notice was issued and the whole project ground to a halt, and various of the blocks faced demolition.

Fortunately, in the event, it was possible to achieve a revised planning permission, but the architect was left with the very difficult exercise of seeking to explain how the “error” arose. The technological costs of unpicking such problems, where more than one party is involved, could be considerable.

#### 6.5 INTELLECTUAL PROPERTY

Looking at the increasing levels of bim maturity, questions arise as to the intellectual property rights relating to the information contained in the database, and ownership of the model at each stage.

In standard construction projects, the owner of a copyright will typically retain ownership of it, but will grant a licence to the employer to use the copyright for limited purposes connected to the project. Such licences could be adapted for use on a bim project so that they permitted extended use of the copyrighted material by the integrated project team, and allowed for subsequent use of work developed at an earlier stage.

The use of a bim protocol could address these copyright issues. The protocol could ensure that all contributors to the model warrant that they hold the intellectual property rights over the contributions that they have made, and provide an indemnity to other parties who may use their contributions, in the event of a third-party intellectual property dispute.

For bim projects, the wording of copyright licences could be expanded to go beyond the typical use for construction, use and sale of a building, and permit the bim contribution to be used for purposes such as adaption and refurbishment.

In terms of protecting themselves from IP issues, participants in a bim project should ensure that appointment documents and bim protocols provide clarity as to the extent of copyright licences and ownership of contributions. There should also be mechanisms allowing commercially sensitive information to be stored separately from the shared model.

## 6.6 OWNERSHIP OF THE MODEL

Ownership of the model is another question to be addressed as the use of bim increases. The employer is generally viewed as being the most appropriate owner, or rather the party most appropriate to bear the residual risks connected with the bim process.

However, this may vary depending on the procurement process used for each project, and it has been suggested that on a design and build contract the main contractor might be the more appropriate owner of the model.

The issue of ownership becomes more unclear as the level of bim maturity increases. There is uncertainty as to where ownership resides at Level 3, but the majority of bim projects at present are not going beyond Level 2 and joint ownership is unlikely to be a problem before Level 3.

If one party makes a contribution to the model they will own the copyright in that work. A party who then amends that work will own the copyright in their distinct amendments, but not the original work.

While the bim database contains interrelated models, each party can be responsible for their own model. However, Level 3 bim involves more collaboration between project parties, and will make it more difficult to identify individual contributions and allocate ownership accordingly.

There are advantages and disadvantages related to ownership of the model. While owners may be liable for non-technology-related errors, such liability may be reduced by the liability of each participant for the contributions they make to the bim process.

It has been suggested that cost and time issues fall within the parameters of ownership of the bim process. The party who owns the model could determine the criteria for extension of time where errors have occurred, and the process for awarding extra payment. On this basis, and as discussed above, it would seem most appropriate for the employer to be the owner of the model as a whole.

**Patrick Perry** is a partner and **Laura Coates** is a trainee solicitor at Clyde & Co

# INSURANCE FOR WORKING WITH BIM

BY PAUL NOLAN



## 7.1 THE INSURER'S POINT OF VIEW

Architects and other members of the construction team are always looking for the best, most effective and most reliable insurance. In order to understand what insurance may be available in changing circumstances, it is essential to understand the way that insurers see these circumstances.

While there is willingness within the insurance industry to adapt to changing contractual relationships, clarity is key for professional indemnity insurance. An insurer seeks to assess the risks of a particular insured party, taking into account its risk-management practices, claims history and hopefully the knowledge of its business that has developed through a long-lasting, mutual, relationship.

In these terms, bim presents both risks and opportunities for insurers. The challenge lies in the fact that bim can expose the insured to claims arising from the actions and defaults of other parties collaborating on the model, in respect of whom insurers may have little knowledge.

If those other parties fail to obtain adequate PI insurance to cover their own potential exposures, it can lead to one party having to bear more than its fair share of the losses. The opportunity comes from bim's potential to provide the benefits of early conflict detection and resolution through three-dimensional modelling.

For the level of collaboration that exists at Level 2 bim, existing insurance provisions should be adequate. Proper analysis of the underlying contractual appointments remains important, as insured parties will wish to ensure, as part of a risk-management process, that they avoid onerous contractual terms that commit them to achieving a particular outcome, or performance specification.

## 7.2 EVOLVING INSURANCE PRODUCTS

As the use of bim becomes more widespread, insurance products will need to continue to evolve and respond to the increasing integration of design, construction and operational information.

Single-project insurance is becoming more popular. This gives insured parties the flexibility of purchasing PI cover for any claims arising from a particular project, as opposed to obtaining such cover on an annual basis.

The advantage of a single-project policy is that paying a one-off premium will ensure that cover is available for both the duration of



the project and for an extended claims period thereafter. As most professional-indemnity policies are written on a “claims made” basis, it removes the risk of the insured party finding that it has insufficient levels of cover in place when a claim is eventually made, which may be many years after a project is finished.

### 7.3 INTEGRATED PROJECT INSURANCE

Integrated project insurance (IPI) goes one step beyond single-project insurance. IPI, which the government has promoted in relation to its bim projects, is joint-names insurance covering a whole project team that insures against financial effects.

Under IPI, the individual parties would give up the right to make claims against each other, and would together pay a project excess in return for no-fault cover. If part of the project went wrong, the insurer would bear the cost above the excess. Underwriting the whole team is a way to accommodate the integrated, collaborative working practices that bim processes envisage.

It has been suggested that IPI could be a cheaper way of providing cover than existing policies because it reduces the amount of time and money wasted when companies pass on risk within a project.

### 7.2 ENCOURAGING COLLABORATION

The benefit of an IPI policy would be that, if anything went wrong on the project, it would be within all parties’ interests to solve the problem as efficiently as possible. Parties would work together, rather than resorting to adversarial contracts.

Other advantages could include positive risk management and the alignment of commercial objectives. IPI policies might also help small and medium enterprises (SMEs), which can struggle to obtain project insurance, as they would be covered under the project policy.

We currently offer annual construction professional-indemnity policies, and single-project insurance for architects and other construction professionals, and we are currently exploring the potential for IPI.

Close collaboration between the construction and insurance sectors is critical in ensuring that architects – and other construction professionals – can obtain protection against potential losses that may result from increasingly sophisticated design and construction techniques.

**Paul Nolan** is a financial lines underwriter at Allianz Global Corporate & Specialty

# CHOOSING BIM SOFTWARE

BY MARC THOMAS



## 8.1 WORK OUT WHAT IS RIGHT FOR YOU

Once a practice decides to start using bim, then it has to buy some software. This is daunting, as it is not only a considerable expenditure but is also likely to lock the practice in to the system for quite some years. In order to make the right decision, it is vital to understand what you want to do with the software, to ask the right questions and to invest in training — and make sure it is the right training.

The first thing you must do is ask yourself what is driving you towards bim. It is vitally important to have clearly understood reasons for adopting bim as these reasons should drive the bim solution that you choose. They can be responses to internal or external needs.

Typical internal drivers have for some time included efficiency of various kinds, whether better internal processes or design improvements. For instance, WhitbyBird (now Rambøll UK) was claiming several years ago that bim tools were allowing it to achieve reductions of more than 10% in the weight of steel frames, before the term bim even became commonplace.

External drivers are usually larger projects or client organisations that mandate specific processes and applications. These can extend beyond the cad production applications. BAA required AutoCAD Architecture and very specific document control processes for the Heathrow Terminal 2 redevelopment. Both CrossRail and Thameslink require Bentley bim design and ProjectWise document management applications.

Increasingly government requirements will drive the adoption of bim. Scandinavian governments have been promoting requirements for IFC data as a deliverable since 2007, and this has had a significant impact on the Scandinavian software market. Several US states are taking a similar path. In the UK, where we are now embarking on the second year of a five-year plan for bim (see section 4), your bim solution will need to produce the government's required deliverables if you want to work on public projects.

## 8.2 SMALL PRACTICES

What about small practices? Small practices often ask what's in bim for them. Surely it is only needed for large and complex projects? Where does it fit in for refurbishment projects?

The answer lies in doing more with less, and setting up with bim need not be daunting. Small practices can be more nimble. The training and setup overheads for moving a large practice to bim are considerable and it takes a long time to widen bim literacy. In contrast, a small practice could quickly become entirely equipped with bim and literate. Each individual would then be able to reap the benefits of “large project” tools.

In terms of refurbishment projects, there is no need to model the existing buildings. A practice can just commission a Point Cloud survey and use that as a background for proposals modelled by bim.

You should ask yourself what you are expecting to get back from your investment in bim. Unless your investment is driven by an immediate project or client requirement the goal should be to obtain a return on the software, setup and training costs by improving internal processes.

Put simply, this means doing things quicker. Bim applications draw walls, not lines arranged to look like walls. While doing so they store metadata about those walls, and so can produce schedules. Moving things around, say a door in a wall, is no longer the digital equivalent of scratching out on tracing paper, but simply the update of a component's position. These processes save time once the initial transition period is passed.

If the requirement for bim is externally driven, then the primary return will simply be being able to satisfy those requirements and actually get the work.

### 8.3 APPRAISE YOUR PRESENT POSITION

When choosing your bim system you should ask yourself what software, data and skills you have now. Does your existing software have a related bim application that may be a natural progression or are you jumping to a new platform? This is an important decision.

How will the new bim application work alongside your existing applications? Will it be necessary — and if so will it be easy? — to share data between the new and the old?

Will your existing applications continue to be used alongside the bim application? If so, can the data produced be used easily by the bim application? Will it be necessary to import the data to a different format (probably!)? Doing concept design in a separate 3D application and the embellishment in 2D cad of the drawings extracted from bim is commonplace.

Do you have an existing data archive? If so, how will this data be accessed if you move to a completely new bim platform?

Do you have an existing staff skills base that can be extended to the bim application or will they have to retrain from scratch? One driver for choosing a particular application is the availability of people with existing knowledge of that application. Jobs are frequently advertised specifying knowledge of particular applications. I seriously question this approach. If you have or hire good people they should be able to adapt to work with your choice of software.

### 8.4 TOOLS FOR SHARING

What do you need to share with others? Bim applications have varying approaches to data formats. Revit stores all of its data in large database files. Most other applications use sets of separate files in the manner that we are familiar with.

Autodesk file formats change frequently, the AutoCAD DWG format every three years and recently the Revit format has changed every year, so data conversion is required to read say Revit 2013 data in an earlier version. While the structure of Bentley's bim metadata changes, its DGN format has a long life, about 15 years, reducing compatibility issues.

However, we need to look beyond just the architect's data. What other file formats might you need to access from the engineering

disciplines? Can the bim application view these files or is there another import/export process?

Will your current processes need to be re-evaluated to operate in the bim world? This needs to be assessed before or, at the latest, in parallel with your evaluation of bim tools. Your process should not be driven by the bim tools

Finally: budget. Most people worry about the cost of bim software licences. However, this can be the lesser and most controllable cost. You will not get a good result from your bim implementation without spending time and money on training and process development. These can exceed the initial software cost and will be ongoing costs.

### 8.5 QUIZZING THE VENDOR

It is important to choose the software that is right for your practice, and in order to gain the information to do this, you must ask your vendor the right questions.

The first questions following the vendor's software demonstration should be along the lines of "That was very impressive, now can you show us some real-world examples?" and "Can we talk to some existing users to find out how the software is behaving in practice?"

Clearly the cost of the software itself will come up at the start of any discussion, and the cost of future upgrades should be directly connected to this. Are upgrades discrete purchases or are they covered by a subscription scheme? How frequent are upgrades and how significant are the changes offered by upgrades?

Autodesk and Bentley have both offered subscription schemes for many years, and since their applications are updated annually the subscription model offers a good deal compared to periodic software upgrade purchases.

Subscriptions can also have other benefits. Both Bentley and Autodesk offer Home Use licences to subscribers. In Bentley's case this is trivially easy to manage and gives your staff non-commercial access to a huge range of applications. There can also be access to training resources and early access to new product versions to facilitate forward planning for upgrades.

How flexible is licensing? Hardware dongles are less common these days but are still used occasionally. Generally licences are now



either provided from a pool by a server, frequently hosted via the internet, or software is locked to individual machines.

Machine-locked licences are a managerial nightmare limiting use to those machines only. Pooled licences allow software to be widely installed but limit the maximum number of licences that can be used concurrently. This is a far more flexible option that allows you to get the maximum use from your licences without forcing people to hot-desk.

Bentley offers a variation of pool licensing with a remarkably liberal licensing system, called trust licensing, that allows licences usage to exceed the number owned subject to annual review and subsequent purchases if appropriate.

## 8.6 HARDWARE UPGRADES

You should also ask whether the new bim software will require new or upgraded hardware. Will operating systems need to be updated? Revit is well known for requiring well-specified workstations, in particular large quantities of RAM to accommodate Revit's large database files that must be copied to the workstation when in use. Any machines still using Windows XP should anyway be upgraded to Windows 7 as soon as possible, as it is a more stable platform.

If you are a Mac OS user, then the fundamental question is which bim applications are available for Mac OS. At present ArchiCAD is the only serious offering. Running PC bim applications in Parallels or Boot Camp on Mac hardware is not ideal.

Hosting bim data on a Mac server is also unwise. Windows servers have become the de facto standard. So the choice of bim software may also require a shift to a PC environment. If faced with this issue, please bear in mind that the computer and its operating system are only there in a supporting role to enable your staff to use the appropriate applications.

Can existing laptops run your bim software, and if so to what level of performance? Might investment in workstation grade laptops be needed for site work or presentation purposes? Alternative solutions could involve the use of appropriate viewing software for presentations or remote access to an office workstation for site work.

What impact will bim software have on your IT infrastructure? There may be a need for additional storage and increased server power to support it. Network speed can be critical. A network that was happy with quite small 2D cad files may grind to a halt when trying to serve a number of users accessing larger bim datasets. Solving this kind of problem may simply require a faster network switch, but it might require a thorough network audit to identify bottlenecks.

## 8.7 VENDOR SUPPORT

Returning to the applications, you must ask the vendor about support options. If there is a subscription, what is provided as part of the scheme? Is this likely to be sufficient or will additional support be available from the vendor, and if so on what basis?

Is any training included as part of either subscription or vendor-support offerings? Is on-demand online training offered as part of these? Is the on-line training localised or sufficiently specific to your needs?

Does the vendor need to be involved in software installation or can this be done by your existing IT support team? Does it install out of the box to UK standards? Once installed, how much needs to be done to get the system running to your own office standards. If you have existing standards how easily can these be ported to the new application? Text styles, layers and drawing borders for instance.

All bim software relies upon component libraries. How comprehensive and UK-friendly are the delivered bim components? Is it easy to build your own component libraries? Can additional components be obtained in useable formats? Can components from the recently launched national Bim Library be used easily?

## 8.8 THE IMPORTANCE OF TRAINING

Any computer-literate architect can quickly pick up the rudiments of 2D cad and appear to be producing drawings efficiently. The associated management processes are relatively simple, largely echoing previous paper-based processes, and consequently should be well understood by staff at all levels regardless of their IT literacy.

But closer inspection of work produced at this level often reveals a range of flaws or bad practices that will cause problems later, especially when the information needs to be shared. Rectifying faults in poorly created and structured 2D cad data can be time consuming enough. The costs of rectifying faults in a bim project can become considerable.

Bim is a more complex environment altogether. Getting to grips with the chosen software is only one part of the task; the wider bim processes can also be complex. You cannot simply assume that bright computer-literate people will successfully work out how to use a bim application in the way that they would with 2D cad or 3D concept modelling. They will only get so far. A structured approach is required from the outset.

Training will need to cover not only the core building information modelling applications, but also the associated processes and other applications. There may be bim viewing software and there will probably be document control or management applications, extranet tools such as Autodesk's Buzzsaw or full document management systems such as Bentley's ProjectWise or Union Square's Workspace. There may be related workflows for text or graphic documents that also generate training requirements.

Typically training for the core bim application should include the following broad areas: drawing in bim, structuring the model, extracting drawings and schedules from the model, creating and modifying components and other resources.

The last item is very important; you need to have sufficient in-house skills to be able to properly modify BIM components as required by projects while maintaining the integrity of your component libraries. Component libraries will become critical assets and are going to require managed care and maintenance. Responsibility for this should be shared. You do not want to find the only person who knows how your component library works walking out of the door one day.

One key aspect is getting the right level of detail. Training must hammer home this concept. There is always the temptation with CAD to over-detail. Drop a few dozen 1:1 detailed models of furnishings and fittings into your building information model, copy a few times and watch performance degrade. It is generally agreed that models should operate at something like a 1:50 level of detail. People must be trained to understand this and to be consistent.

They also need to understand the power of metadata. Take doors as an example. The placement of doors in the model could use quite simple graphics, the object being to produce representative 1:50 plans and internal elevations. This basic graphic generates a component in the project dataset carrying a range of metadata that can be extensive. By adding to and varying the metadata, that simple graphic can result in a comprehensively detailed and easy to revise door schedule.

## 8.9 CUSTOM TRAINING

Custom training is worth considering. Although it appears expensive, it will have the advantage of using your own environment and standards, thus being clearer to your staff and avoiding potential confusion caused by generic, possibly US-generated material. There is the additional benefit of reinforcing your own office standards.

Take advantage of any Home Use licensing offers to allow staff to self-train at home.

What BIM skills are available in your existing team or the pool of potential recruits? Even if candidates claiming the relevant skills and experience are available, can you be sure that their skills will actually match up to the requirements of a properly structured BIM project? It may be worth using an evaluation tool such as KnowledgeSmart to gauge people's abilities.

Senior staff are unlikely to use BIM directly, so it is essential that they gain a good understanding of what BIM is intended to do, what it cannot do and exactly what tools are available to their office.

For example, the majority of offices will not wish or be able to support multiple BIM platforms. Larger projects may mandate a specific application that is not already being used by a practice. It is crucial to the financial viability of such projects that the implications of this are understood by the senior staff who are actually negotiating a project's terms of appointment.

A finely balanced fee proposal could lose money from the start if the training and process costs of working with a new BIM application are not factored in or an alternative process using available software cannot be agreed.

**Marc Thomas** is an IT consultant at Isisst Project Technology and

# BIM STANDARDS AND REGULATION



a chartered architect with more than 20 years' experience  
<http://isisst.co.uk/about.asp>

### 9.1 INCREASING REGULATION

Many architects may feel as if they are already drowning in regulations, and the knowledge that the British Standard that applies directly to bim is being extended, that the RIBA stages of work are being changed to reflect the reality of bim, and that even Uniclass, the classification system that underlies specifications, is changing may just elicit a frustrated groan.

But in fact all these things are being done with the intention of making life easier, not more difficult. BS1192, the standard that underlies bim, is to get two new parts, one of which is nearly ready and the other is in the early conceptual stage.

The first part of BS1192, which was published in 2007, grew out of work done over years by contractor Laing (now Laing O'Rourke), in particular at Terminal 5, Heathrow. The aim was to cut the 20 to 25% of waste that was created through wrong information in the construction industry. The team at Terminal 5 created a protocol and succeeded in cutting the waste by around half. Eventually this protocol became BS1192.

Mervyn Richards, who was one of the Laing team at T5 and who eventually wrote BS1192 (he is now an independent consultant), explains that although the standard was not specifically aimed at bim, the wider adoption of bim made it even more important. "With bim, if the base information is not correct, everything that comes from it is also incorrect," he says.

Government requires BS1192 to be used on its projects, and some clients are now asking for it as well. Bim enthusiasts like Robert Klaschka are keen on it, because it creates protocols for working without the practice having to create them itself.

Yet in the BD survey of practices (see section 3), only 4.4% of respondents said that they had used all the procedures listed in BS1192, and only a further 30.7% had used some of them. Even among the 66 respondents who said that they regularly used a bim workflow to exchange models with engineers and contractors (that is, among the most committed and advanced of bim users) only 12.3% had used all the procedures in the standard, with a further 61.5% having used some of them.

### 9.2 EXTENDING THE STANDARDS

Not only has BS1192 become more important with the wider adoption of bim; there is also a need for more of it. What will eventually become BS1192-2 has just been issued for public comment, and should be published in final form in June or July.

This deals with production information and in particular the problem that any changes that are made on site (for example to foundations) must be fed back into the model. If this is not done, there can be costly repercussions — or, put crudely, parts of the building will not be correctly aligned.

The other new element, which will become BS1192-3, will deal with the operation of buildings. Government is consulting with facilities managers on this, and intends to issue a draft later this

year.

For Richards, the whole point of BS1192 is to ensure that bim becomes “a process of clash avoidance rather than clash detection”. Its widespread adoption should, he believes, halt the proliferation of external bim co-ordinators who are paid to rebuild the bim models that have already been built, and check that they work properly.

This type of double working is exactly the sort of wasteful working bim is intended to eliminate – and it’s a drive to eliminate waste that led to the government embracing bim. External bim co-ordinators should not be confused with the person within a practice who co-ordinates a practice’s bim work – a role that is necessary, and for which BS1192 will be an enormous help.

BS1192 is also designed to avoid the type of overworking that can be tempting. It is very easy with bim to produce something at a very early stage that looks as if it is highly finished. Architects can be seduced into putting in too much work at a conceptual stage, or clients can ask for too much.

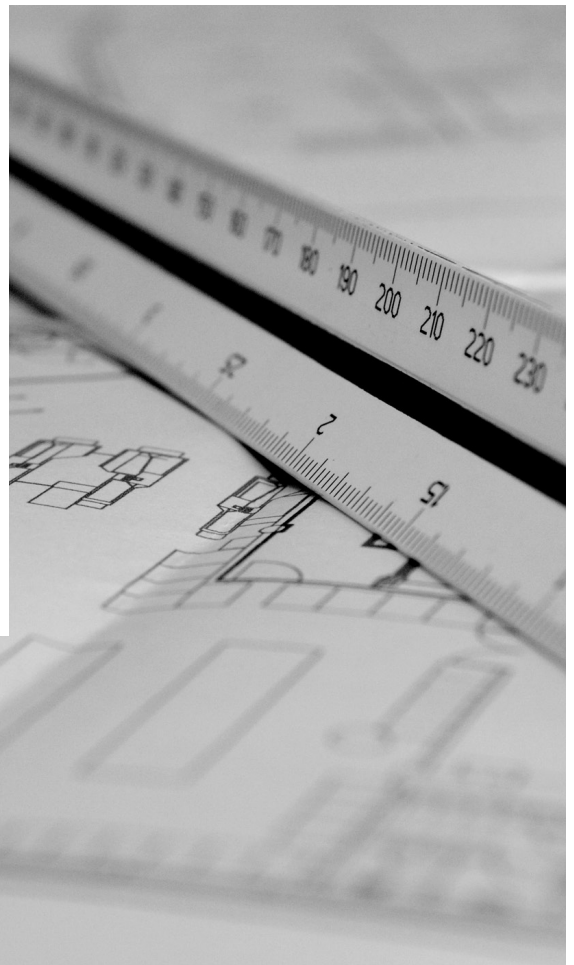
“The whole thing about BS1192,” says Richards, “is to stop that happening. All we are looking for is the minimum appropriate information at all stages.”

### 9.3 THE RIBA PLAN OF WORK

But bim does change to some degree the order in which work is done, and this is being recognised by changes in the RIBA Plan of Work. This is happening in two bites. A “bim overlay” to the existing plan of work is out in draft form now. Like the green overlay that was produced previously, this is by necessity a patching, designed to recognise the different way that jobs work under bim.

“It’s a different way of doing things,” says Richard Brindley, executive director for membership and professional support at the RIBA. “The actual processes are still there, but how they fit together is very different.”

A more radical rewriting of the order of work will be published next year, taking into account not only the two overlays, but also changes in procurement. It will be published on the 50th anniversary of the current plan of work and, to mark the fact that it is radically



different, will identify the stages of work by numbers rather than the current letters. There should therefore be no confusion between the old and new stages of work.

#### 9.4 CLASSIFICATION SYSTEMS

Another system that is changing is Uniclass, the classification system that is used to identify all the elements in a building's specification. Uniclass is being reclassified to make it sit better with bim, and to make it work effectively with COBie, the system within which the government wants information to be delivered on its projects. "Uniclass is being updated to allow us to co-ordinate through classification the specification process with the bim model," says Richards.

The RIBA is also taking part in a research project through the Technology Strategy Board that is looking at producing metadata that allows projects to be tagged in such a way that information can automatically translate into and out of different classification systems.

This is aimed particularly at international projects, where those working on the projects may be based in different countries. Put at its simplest, it would automatically translate between metric and imperial measures, as well as dealing with a number of more complex issues.

There is a subset of architects and members of other construction professions who love grappling with these issues. Most, however, find them deadly and would rather get on with designing. Luckily there are people dealing with them.

For the practising architect, there are two lessons to draw from all this. If all design work requires consistency, checking and an appropriate methodology, then bim requires an even more consistent approach. And there are people busy working at standards, at classification and phasing, the results of whose efforts will be to make achieving these goals with bim simpler and not more difficult.

#### 10.1 DIVERSE APPROACHES

# BIM STANDARDS AROUND THE WORLD



The UK government has done much to advance the conversation around bim adoption in the UK, but architects working abroad have encountered a range of different approaches and widely differing expectations of bim deliverables.

In a small handful of countries, governments and public institutions already have their own bim standards which they expect all contractors to comply to.

The United States, Singapore and Finland offer very different examples of the approaches being taken towards implementing bim standards and all are seen as world leaders in terms of bim.

## 10.2 THE UNITED STATES

In the US, central government has taken a relatively “hands off” approach, assuming that the industry will work everything out for itself, resulting in a large amount of unregulated experimentation. This has led to the development of many industry-leading bim products and processes. Software developers have spent millions on marketing the benefits of bim to architects, contractors and clients and awareness of bim is far higher among clients than in the UK and most of Europe.

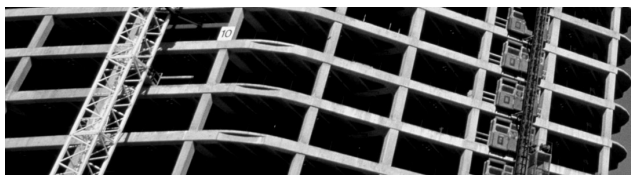
But despite the publication in 2007 of a National Bim Standard document by the US buildingSMART alliance and the National Institute of Building Sciences, the lack of central leadership has created a patchy – and often confusing – landscape for architects to deal with. Specification of a preferred software package is fairly standard in the US, but varies from client to client.

Each government department uses its models in a slightly different way and asks for slightly different deliverables, and there is also variety in the standards implemented by the major college and university campuses.

The General Services Administration, an independent government agency which manages large swathes of government-owned property, began asking for bim deliverables with a view to improving its spatial programme validation but has since developed more specific uses for its model focused around energy assessment, safety and security.

Penn State University has some of the most respected bim implementation strategies and standards. It has been developing its bim project execution planning guide as a research project since 2007. In April 2012 it published a bim planning guide for facility owners, which could prove an invaluable document in client education.

Indiana University has made its bim standards and project delivery requirements document available online. Originally published in 2009 and updated in January of this year, it is a good example of the approach taken by many universities looking at the



management of large campuses. It asks for the delivery of DWG files via AutoCAD and a Revit model as well as COBie data sets.

### 10.3 SINGAPORE

In Singapore, the aim is to have all projects delivered using bim by 2015 and the government is providing financial incentives for companies to use bim. Parties involved in a bim construction project – be it public or private sector – will soon be legally obliged to incorporate a document known as the Bim Particular Conditions in their contract documentation. This can be adapted for specific use where it does not cover all the issues that might occur on a project.

Singapore's Building & Construction Authority is also issuing a bim guide, outlining project stages, bim deliverables and guidance on ownership and responsibility for models. IFC data sets are generally preferred to COBie. Drafts of both documents are currently available to view online (see further reading) and the final versions are due for publication on May 14 2012.

### 10.4 NORTHERN EUROPE

In northern Europe, IFC data sets are more commonly requested than COBie, and clients veer more towards a “best tool for the job” approach rather than specifying specific software packages.

Finland's approach to bim focuses firmly on the design phase of construction, looking at collaboration and quality assurance. It helps that the country has a history of open standards.

State-owned Senate Properties has been implementing bim in its projects since 2001 and was one of the first public European companies to publish its own bim requirements in 2007. These are available in English on the company's website. The Finnish government has recently published a national bim guideline that will be available in English this summer.

Denmark now has a legal requirement for all public projects to deliver IFC data sets, but the government remains unwilling to place any further definitions on delivery methods or work processes.

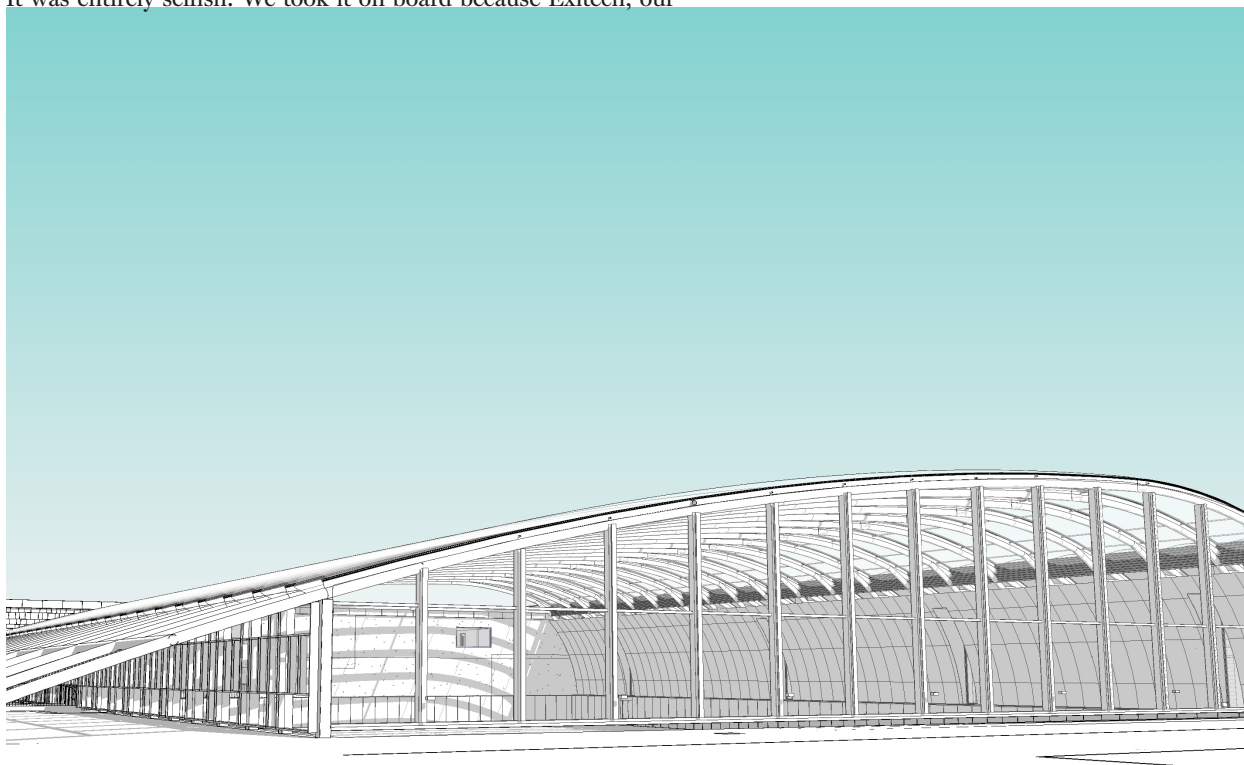
In Norway, bim is a requirement on public projects, and the country is one of the leading supporters of the openBIM initiative. Led by collaborative construction organisation buildingSMART, this aims to create a common bim language and international standards that do not rely on the specification of particular software packages. Nineteen countries – including the UK and most of northern Europe as well as China, Korea and Turkey – have already signed up.

### 11.1 THE EARLY ADOPTER

ARCHITECT CASE STUDIES



It was entirely selfish. We took it on board because Exitech, our



software provider, sold it to us on the basis that it would make things quicker, easier and more efficient. All the things people take for granted in it now. That's what sold it to us.

We took on four or five licences to begin with but after a few months we decided it was worth diving in. We'd been waiting for something that could do what Revit could do at that time. It was friendly enough for our staff to use. So we just went both feet first really.

We had one of the largest orders of Revit at the time — a whole 24 licences. Back then that was quite a big chunk.

I think it's put us in a good position now. We did our first project in 2005 using Revit in a bim manner, but it was purely internal at that point. No one was really talking about bim — clients weren't aware of it and most of our consultants weren't aware of it. Now all of our office are using Revit on a daily basis and we're making some headway with being one of the leaders of bim, actually doing it on a day-to-day basis.

Because we were early adopters we knew there were flaws with it at that point, so we didn't want to shout about it too much as we knew people would find the weaknesses. But now we have the experience and the back catalogue to show to people.

The technology is not quite where we want it to be yet. We aim to be at Level 3 bim and that doesn't work yet unless you co-locate

**Name of practice:** KSS Group

**Number of architects:** 36

**Number of staff:** 73

**Practice location:** Westminster, London

**First use of bim:** 2004

**Software currently used:** Autodesk Building Design Suite, SketchUp

**Level of investment in bim:** Estimated £500,000 since 2004

**Number of live bim projects:** 34

**Biggest project carried out using bim to date:** £250 million sports stadium

**Interviewee:** Casey Rutland, associate director

all of your design team in one office rather than having everyone working in different offices on one model.

That's one of the weaknesses with it. It's not the organic, everyone-loading-into-a-single-model, in-the-cloud environment — we're hoping it will be there in the next few years and that's where we'd like to be.

## CHANGING ATTITUDES

The biggest challenge was changing the way people work. Whenever you introduce new technology people will try and force the way they've done things in the past onto the new processes. Bim needs to be done quickly — it's a rolling day-to-day, week-by-week process. You can't keep waiting for things to be approved.

Everyone has come around now. We dealt with resistance through exposure. We sat our older staff next to younger members so they could see the iterations of projects appearing overnight. We do still have people who work in a certain manner but we've found ways of working their processes into our processes.

Contracts are tricky. Currently we're only working on three schemes where the clients or contractors have requested that we work in bim. This is where we come across difficult negotiations with our consultants — if they're not being asked to do it they see no reason to. So we're looking for people who are willing. Our contracts are the same as they were unless our clients ask for bim deliverables.

We do use the RIBA stages. As a practice we tend to over-deliver anyway. We're always a few work stages ahead in order to give the client the best results. When we get to data drops we're always slightly concerned that we're giving them more data than they've asked for and giving too much away. The RIBA is a long way along the line of realigning its work stages with the bim process and we're looking to feed into that as well.

It's tricky to say if we've had return on investment. We've spent nearly half a million since 2004 and it's difficult to determine what is for bim and what we would have spent anyway on our other processes. The recession threw a bit of a spanner in the works. Our team numbers have reduced — we're churning out more work and faster but we are being paid less for our projects.

## DOING THE WORK OF FOUR PEOPLE

The first thing I'd do if I left and set up on my own would be to buy a bim software platform because I know that if I was using bim, I personally could do the work of four people in a 2D environment.

We would like the opportunity to work with more people. They just need to get on with it. We're in a situation now where if we're in a workflow that's bim-based and we're asked to work with an M&E engineer who is 2D based it's more cost and effort for us to work with them. The more bim people we have to work with, the better.

### 11.2 THE DOWNSIZING PRACTICE

In 2000 we bought three licences of ArchiCAD. We were using it



mainly for 3D visualisation at the time. One of the architects that we'd employed was an ArchiCAD user and wanted to continue to use it. We needed the facility to do 3D, so we said OK.

In 2001 a venture-capital company came to see me and demonstrated Revit 4.1 and we thought, well, that's a big step up. I'd never seen a parametric model before. I'd always envisaged a proper 3D modeller whereby you modelled in 3D and took all your information by slicing the model and this was the first program I'd seen where you could effectively do that.

You could only lease it on a monthly basis, but we kept a close eye on it. It was a big surprise when Autodesk bought it and we thought, well this is going to go places now. Then, in 2004, Revit 8 came out and we thought we'd have a look at that, trialled it, then bought the software in Feb 2005. We had three licences. We had 15 staff at the time.

We started to do a lot of visualisation and a lot of the residential planning work with Revit. We could give the planners a good 3D representation of what was in the planning application and that gave us a distinct advantage.

**Name of practice:** NC Architects

**Number of architects:** 3

**Number of staff:** 7

**Practice location:** Swindon

**First use of bim:** 2007

**Software used:** Revit, Revit Structures

**Level of investment in bim:** £60,000

**Number of live bim projects:** 4

**Biggest project carried out using bim to date:**

£7 million Ferrari garage for Dick Lovett Group

**Interviewee:** Derek Marshall, director

Then the recession hit and in 2008 we cut our workforce by half. But we then decided that we would do all new work in Revit. It was an opportunity. The downturn meant we could look at Revit and train people up in a much more thorough way with the time to do it. It also allowed us to refocus our client base.

#### CORPORATE ONLY

We decided we would only have corporate clients and we cut our client list down to about six major clients. The recession was hard but those clients kept us ticking over. Having Revit meant we could produce information efficiently and quickly.

There was a different process to be learnt through the office. One of the major things was that as soon as you enter the design stage the accuracy of design is of paramount importance. Some of the architects found that difficult because they were not used to working in such detail and to such strict parameters so early in the project.

That is one of the fundamental differences in the workflow. One of the things that we have learnt is that the data from design in a bim workflow has to go further so that information has to be accurate and correct from day one.

That did cause a fractious period in the office. But having this accuracy of information and data input has always been the philosophy of the office. It just needed a refocus of thought and training.

Usually when you design something, initially you're only dealing with spaces and ideas and concepts. So the need to actually understand the nuts and bolts of the design is non-essential. But moving to a bim workflow, it becomes very important for the workflow in the office if you are not going to have to redraw things.

Obviously with a smaller office you can get through that. With a couple of hundred employees it must be a nightmare.

All our bim projects are new build. Because we're one of the few small practices in the area who understand the bim process, and we're moving into Level 2 bim where we have to work more collaboratively with other parties, we're finding that some of the local builders are asking which practices are familiar with a bim workflow process. This has been brought about by the government initiative. A number of local contractors in the area are doing local authority and NHS work and are beginning to ask various questions about who to go to for bim.

#### HOUSE-BUILDERS

The big problem is the national house-builders. They are very traditional in the way they procure work and have a Luddite attitude. The bim workflow process would cost them nothing, it's just that they have to make an effort to make the decisions earlier on in the process.

I have talked to various contacts and people that I work with but you just see the shutters come down. I don't know whether this is

a refusal to understand it or if they think it's going to cost them more money. Not understanding the process, they don't see that they could save a tremendous amount. I don't think anybody has done a study of the costs that national house-builders incur with the way that they do their work.

The only way they'll change is if they see a cost benefit or if government legislation comes in to force them down this route.

#### GETTING THE INDUSTRY ON BOARD

The Ferrari garage, a £7 million project, was virtually run by one architect because of the bim workflow. We would have put at least four people on it in the past. Our income now is the same as when we had 14 people, and we have just seven staff. It's very gratifying.

Yes, we can sit here with all the technology and I'm very fortunate that I understand it and that my board of directors understand the technology. We'd like to see bim processes and workflows rolled out to every aspect of the building industry.

We are a bit frustrated about that. We are building virtually and obviously the aim is to iron out all the problems with design and construction in the computer and then building what's in the computer when we go out on site. That's where the big savings will come. We are ready for that but we're struggling to find other like-minded consultants, builders and sub-contractors who understand the process.

Clients will have a big say in getting bim into their construction projects. The government has already done it. Now we've got to get

all the other people that develop to understand the process.

### 11.3 THE GREEN ARCHITECT



I first used Revit in version 6 some years before I joined Architype in 2006. When I came to Architype they were doing some 3D stuff but not anything that would really be termed bim. The key thing for me was observing a number of people sitting side by side, where one person was drafting a section, another person drafting a 2D plan and then somebody else working out the design in 3D. When one person resolved something the other two would have to redraw it. You got a lot of duplication of work and potential co-ordination issues.

I made a case in the office for investing in bim concept so that we could get the direct gains and avoid some of the issues of duplicate working. There were a lot of obstacles. For one thing, Architype works in a Mac environment and I was proposing Revit, which was Windows-based. There was general reluctance by a lot of people to learning new software and questions about whether it would really

**Name of practice:** Architype

**Number of architects:** 22

**Number of staff:** 36

Practice location: Hereford

**First use of bim:** 2006

**Software currently used:** Autodesk Revit 2012, Vectorworks, Ecotect, SketchUp, PHPP (Passivhaus planning package)

**Level of investment in bim:**

£70,000 over five years

**Number of live bim projects:** Six

**Biggest project carried out using bim to date:**

The Willows, a £17 million secondary and primary campus for special needs education in Wolverhampton

**Interviewee:** Elrond Burrell, associate

live up to the promises.

We'd already had a few debates in the office about cad standards and methods of working, and this sparked off that whole debate again. There is a segment of the office that says why are we talking about cad, let's just get on and make architecture. In fact so much of the cad standard aspect of producing drawings is taken care of for you - that was my experience with Revit and other software is similar.

The next step beyond debate was that by coincidence we needed some new hardware and the newer Macs were capable of running Windows on virtualisation software - Parallels in this case, but it could have been something else.

### GETTING STARTED

I installed a trial version of Revit on the new machines and, with a part I student, modelled the basics of the project we were working on in a couple of weeks to demonstrate how quickly we could produce useful documentation and 3D visualisation. The part I student didn't have any previous experience of it.

That won everyone over. That's when we made the initial financial investment in hardware, software and training. Even if we hadn't done this we would have had to upgrade our hardware anyway so it's not all pure investment for the purposes of bim.

We just proceeded on that one project, which is still the largest project we've done to date. We went in at the deep end and said we're going to do it because the benefits are so great on this job, rather than testing the waters on something easy. We had a notional plan B if we needed to because we could export the drawings out in DWG format and work on them in Vectorworks. But we never had to do that.

We had a team of six people working in bim at its busiest. We then went down to just two people working with it. People who had worked in bim then went on to other jobs and said "Can we use Revit, please?" It was led by people's skills and their interest in using it rather than a top-down diktat saying everyone is going to be using it from now on.

During the last year we've had discussions between the London office and the Hereford office about whether we're going to do it across the board or selectively. We're now in the process of moving to having the capability to do it on every project in both offices but we'll still make an assessment because there are always going to be some cases where the architects don't want to go for it.

### CONTRACTOR DEMAND

Where we get clients asking for it we can say "Yes, we have the capabilities". We've had a number of jobs now where it's been requested. On one job we were working with a local authority that used Revit and wanted to take the model and carry on with it when we finished Stage D.

On a design and build job, the contractor specified that to be on

its team we needed to be using Revit. It was seen as being helpful in terms of winning the bid - adding value for the client.

We had another job where we were the client's architects and also being novated - but the contractor side of it is being sold on the bim process. There's only one project where we've had the end-user client specify that it wanted bim, because it was a local authority. All the demand has been from the construction team side really.

Using bim both is and isn't about efficiency. Because it offers you a lot more you end up doing a lot more for your own benefit. It's a bit like any tool, when it makes you more efficient you don't do the job quicker, you just end up doing more things. Some of the more mundane tasks are managed more efficiently.

People are thinking more in terms of how they're constructing a building rather than just drawing lines on a piece of paper or a screen. They are thinking about the buildability, about the construction of what they're designing. It's hard to quantify. It does reduce the duplication of work - on the other hand it's easy for people to get sucked into the modelling more than they need to.

#### PASSIVHAUS

We see bim as a particularly useful tool in terms of designing to Passivhaus standard. There's so much emphasis on getting the fabric to perform well and eliminating the thermal bridging, closing the gap between design and reality. You can cut a section through anywhere and make sure that the design is what you think it is and provide that information to the contractor so they can actually build what you've designed. The production side of things is great, but we want to see it really supporting us to design buildings that really perform as we promise.

I don't think bim in itself makes collaboration easier, but it does support the collaboration process. You can sit down together as a team and see what's happening anywhere. There are a lot of times when the contractors suddenly understand what the design is about, whereas with a drawing the whole situation isn't always obvious. It definitely forms a useful and graphic part of that process.

It is brilliant when we send our model off to the engineers and they send theirs back and we can literally see where their beams are in our building. But it doesn't replace sitting down together and looking at it together.

In terms of client consultation, a 3D model means that they can understand what their room looks like. We still use card models, but being able to do it for any room anywhere when you need to.

#### TRAINING

We did a mixture of formal training and people learning on the job. Most people had two or three days' formal training from an external company. We had a trainer come in again and sit with people at their desk while they were doing a project task to see if they knew what they were doing or needed help, which was great.

We've also had other more bespoke training sessions, and we do

a lot of in-house ad-hoc training on the job. We're in the process of setting up a more formal in-house knowledge sharing as well, but we're usually so busy doing the job that it's hard to find time.

#### ADVANTAGES

We can have fewer people produce the same number of drawings. For space schedules, we used to spend days going through Excel spreadsheets checking the briefing areas against what our current areas were. In a model we can make changes as we go along and check the schedules straight away. That's a massive time saver. Once you've got a building modelled you can take sections anywhere.

I think that we're largely converted. I did a presentation to the rest of the management team later last year and everyone there was completely won over. People who haven't used it might still be slightly sceptical, but it's only a matter of time.

#### 11.4 THE DISAPPOINTED USER

I knew that ultimately we wanted to use it. I was getting frustrated.



I've been using SketchUp for about 10 years now and really love it but it is limited by the fact that once you've made the model it's hard to extract more than just the model from it. The way bim is sold is that you build the model and then at a press of a button you get all your information from it, so it seemed a sensible step for all the reasons that they say.

We looked at various options. We started looking at the Autodesk suite, at Architectural Desktop which was about £6-7,000 for one seat. That was a lot of money at the time. Revit had only just started becoming more popular and wasn't as big as it is now. Graphisoft offered what seemed to be the best value for money because one seat was about £600.

So it was a decision based on the fact that there didn't appear to be very much to distinguish between the different packages, and with Graphisoft it is interchangeable with DWG and you can just pull things in and out, and it is also the best value for money.

We bought three licences and we still only have three because of the problems we've had with it. We went for some training in-house to start with, and we also had some training where they came to visit us in our office. We had already started modelling up this

**Name of practice:** St Ann's Gate

**Number of architects:** Six

**Number of staff:** 10

**Practice location:** Salisbury

**First use of bim:** 2008

**Software currently used:** ArchiCAD, AutoCAD, SketchUp, Photoshop, InDesign

**Level of investment in bim:** £4000

**Number of live bim projects:** 1

**Biggest project carried out using bim to date:** £1.6 million church extension

**Interviewee:** Melanie Latham, partner

building which was fairly complicated but should have been feasible.

The initial training misled us slightly in terms of how best to use the software, but my bugbear really is that they made it sound as if once you've built your model there's nothing else to do.

And I think that's the big problem with bim - we're made to believe that it's effortless. Had our expectations not been raised so high at the outset I think our learning curve would not have been so frustrating.

### HISTORIC BUILDINGS

Our practice, and the sort of work we do, is a big factor. If we were a practice that just did new houses from scratch it would be a much easier package to use but we're trying to tackle a lot of existing old buildings, which are not easy to model. You can do it but it's complicated and time-consuming.

We deal with ecclesiastical work as well, and we deal with a lot of listed properties. We have long-standing clients with 2D cad records that go back a long way and changing that isn't really feasible. So we have to keep the two prongs going. Moving between one package and another constantly doesn't help — I think you need to immerse yourself in bim fully to really get the benefits from it and we didn't have the luxury.

We got to a certain stage with the model on our first attempt and the programme for the building work was looming. Because of the training having been inadequate, we basically had to export everything and finish it in cad. We chalked it up to experience and accepted that it was part of the learning curve.

We did persevere with it and got the trainer to come and have a look at our model and give us some feedback on what we'd done and it slowly started to transpire that we do have to do quite a lot more drawing in 2D in bim than we had been told. I'm pretty sure that most of them work on the same basis.

### POOR QUALITY DRAWINGS

When you pull the 2D drawings off the model there is still quite a bit of work to be done to tidy up those drawings and you're never told that, which is a bit of a con really. Had we been told that at the outset we would have been able to know when to draw the line on the model and it would have saved us time.

If you're aware of what the software can do best you can make the most of it, otherwise it's incredibly frustrating. We've got a high standard of output of drawings and we wanted to ensure that that quality was maintained. The drawings that were output from the model were pretty crap.

It's almost as if the manufacturers don't want to admit that the software has limitations and other users seem to be evangelical or struggle with it but don't want to admit they struggle with it. You don't know whether to speak out or if you don't just get it. You're immediately shouted down as a bit of a Luddite.

### LIMITATIONS

Four out of the six architects have tried it and we've all had the same experience with it. We're all fairly computer literate and appreciate there's a learning curve. We can't just switch over and just use it from now on ad infinitum.

It's not an intuitive programme, you have to learn how to use it and you do need practice and even if you're good at it, it does have limitations.

I think people like the RIBA should be looking into this to assess whether these limitations are a serious issue. It's not actually as time-saving on some jobs as it's made out to be.

There is also the issue of being seen by your peers as lesser somehow for not achieving it. I don't know whether or not that has an impact on workload for people. The software should be about making my life easier, and if it isn't and it's not more cost-effective for my clients, then I wouldn't recommend it. I'm not going to be embarrassed by saying this isn't the right project for it.

The more people tell you these things the more you start panicking about it. We will persevere but it will take particular projects. We've had it in the office for the best part of four years now and we haven't seen any jobs that we've done on it make a profit. It's not as quick and as easy as people make out.

It's not a one-size-fits-all solution. Smaller practices are being made to think that if they're not in it they're going to be out the loop forever. But I don't think it is for everybody.

Most of the contractors I know still want paper 2D drawings. There are some people out there who work on the cloud constantly and make the rest of us feel like Luddites, but they're not in the market for the sort of work that we're doing. There's a misunderstanding that what they're doing applies to smaller practices in the provinces.

### 11.5 THE ACCIDENTAL USER

We didn't realise we were using bim. We initially bought Revit [by



Autodesk] because we could see productivity advantages in staying in a single environment all the way through the process — the advantages that are inherent in the software rather than by doing bim. It was only really later that we started to understand what integrated project delivery was.

What we were doing previously was modelling our projects in 3D but in Rhino and then reverse engineering them into 2D drawings. That process had a lot of waste in it because we were effectively doing things twice.

We looked at all of the big software players but the decision probably came down to the enthusiasm of the reseller we were talking to, because they could all pretty well do the same thing.

Straight away we felt that we were getting productivity advantages, just doing 3D modelling using the software. For small practices, that is possible because the sorts of projects that you start on are the ones where you can avoid being overwhelmed by the new software.

Our first project was a £1 million residential scheme that was very straightforward. We completed the initial training — three days with the three technical staff we had at the time — and jumped straight

**Name of practice:** David Miller Architects

**Number of architects:** Six

**Number of staff:** 10

**Practice location:** Central London

**First use of bim:** 2008

**Software currently used:** Revit, AutoCAD, Rhino  
**Level of investment in bim:** £30,000 a year for the past four years

**Number of live bim projects:** At least 12

**Biggest project carried out using bim to date:** Oaklands School, a £10 million school secondary school in Tower Hamlets, east London.

**Biggest job taken to planning:** a £22.5 million hotel in Aldgate

**Interviewee:** David Miller, director and principal architect

into the project, but if we had got into a pickle we were always in a situation where we could reverse out into 2D. I don't think a bigger practice with bigger projects could have had that same luxury.

### BIM CHAMPION

Just over two years ago we committed to using the software on all of our projects and at that point we hired a bim champion — an architect called Letizia Simoni — to carry out all of our in-house training. She also had a post-graduate degree in building information modelling.

She effectively developed a training programme specific to us, which broke down about six days' worth of training into 40-minute bite-sized pieces. People weren't having to take big chunks of time out of projects. It made it quite entertaining. All new starters did "bim boot camp" for the first week that they were in the office, just doing training before they had any project distractions.

When you are developing your bim capability, I think you definitely need a bim champion. But now we have blown that role apart. We now have lots of bim champions for different parts of the process. What they do is develop their skills and then — because we are small — they share them with everyone else, so there's no longer a need for someone who is effectively a super-user.

### COLLABORATION

Initially I don't think clients were aware that we were using bim because our deliverables are usually still 2D drawings. But more recently clients have become more interested and very inquisitive about it.

We knew that we were getting productivity advantages from working in our silo, in our lonely bim environment, but then we began to collaborate with engineers.

I think there's something about the logic of the process that's very attractive to structural engineers. M&E engineers have been more difficult to find, but that's more to do with the procurement structure. We have thought about getting more involved with M&E.

We're conscious that bim is almost an opportunity for multi-disciplinary practices to become fashionable again — or certainly collaborative teams. If we were bigger we'd like to be multi-disciplinary. But as a smaller practice we need to find other consultants we can form teams with to offer an integrated proposition to clients.

Being a smaller practice helps — we've not had change-management issues. I think for a bigger practice there's quite a lot to deal with apart from just buying the software. We don't have to convince middle management. We were able to just make the decision and implement it. The barrier of entry is really cost for a small practice.

We've actually tracked what we think the implication has been. If you look at the cost of the investment next to your other costs and

your technical staff costs it isn't that large. If you've got good staff and you're able to give them tools that make them more productive you're going to get payback in the long term. We believe we're beginning to see that now. It does take a little while. Once you get to a level of experience you are able to do more with less, to be more efficient.

We have quite a big project at the moment on Lisson Grove for Westminster Council and the bim tools have allowed us to develop that project very quickly indeed, which was one of the requirements of the brief.

We've done a trial COBie data drop. It worked but really we're still trying to understand exactly how to implement it, and whether it will change the traditional workflow. If the COBie data drop in effect creates gateways in the project, then those may well become the milestones people are working to rather than the RIBA stages.

#### STAGES OF WORK

Because the way you're producing information in a bim environment is structured differently to the RIBA stages of work it does make it necessary to develop a new RIBA Plan of Work.

At the moment we've developed our own version. We've taken the RIBA Plan of Work and written our own bim plan of work, to help us understand what our workflow would be with the tools we've got at the moment.

Because we're small and we were growing, we've been able to structure the way that we run the business around the bim workflow. Because it's very process-driven, that's led into ISO9001 and ISO14001. Because the bim process is very structured, you can build your design management process around what's becoming available.

#### 11.6 THE COLLABORATIVE ARCHITECT



We recognise that technology is not just a support function. It's a business driver. By using the right technology you can gain a competitive advantage and make life a whole lot easier, but you do have to match that technology quite closely to the business process.

We would apply that to any technology, be it word processing software or a bim process. We very much focus on the process first and then match the technology to that. Bim is not something you can just go and buy. You have to get the protocol correct or it will fail.

We were using a collaborative cad system 15 years ago, but in a 2D environment. You could say that was a bim environment because it was collaborative across our offices.

The principles of collaborative working were quite familiar to us. We were using products like CodeBook for healthcare planning and so on — it takes briefing information and presents that as drawn information on the cad drawing to enable you to schedule rooms, accommodation schedules, equipment schedules, automatically for 2D cad. Bim isn't necessarily about 3D.

#### PILOT PROJECT

**Name of practice:** HLM

**Number of architects:** 100

**Number of staff:** 130

**Practice locations:** Sheffield, Belfast, Cardiff, Glasgow, London, Plymouth, Johannesburg, Pretoria, Abu Dhabi

**First use of bim:** 1990s

**Software currently used:** ArchiCAD, Artlantis, Cinema 4D, SketchUp, 3D Studio Max, Piranesi

**Level of investment in bim:** £200,000 over last two years

**Number of live bim projects:** 18

**Biggest project carried out using bim to date:** £41 million education building

**Interviewee:** Marcus Earnshaw, associate director IT

We collaborated in a 2D environment for quite some time until we got to a place where we could experiment with 3D exchange of information, which we did in the first wave of the Sheffield BSF programme around six years ago, exchanging information with engineers.

We found that structural engineers had been designing in a 3D world perhaps a little longer than we had, so they were keen to embrace that, to take our information and give us theirs. We were involved with about nine schools on that team, but we only completed one as a 3D bim project. It was very much a 3D bim pilot for the team involved.

We carried on predominantly in a 2D environment. Although that initial experiment worked for us, it was a bit of learning curve and was a little bit slower. But we thought we would do it again with the right project and the right time, rather than just saying we're going to do it on all of them. The projects that came along just lent themselves more to the 2D format.

#### NEW SOFTWARE

Two years ago we made the decision to move from MicroGDS to ArchiCAD. We're investing £300,000 over a three-year period. We were looking at the process we wanted to follow and it was very much to enhance the bim process we felt we were already following. We recognised that the software we were using wasn't as good as alternatives out there. Our software wasn't perhaps up to what we wanted to do.

We tested Revit and ArchiCAD to decide where we could go next and what software would fit around our process. We found that ArchiCAD was a better product for us. Our designers preferred the look and feel of ArchiCAD, and the fact that it gave you more freedom. It also supports an open bim environment, which we felt was key.

Open bim is a campaign that's been led by Graphisoft to promote non-proprietary file exchanges. Everybody uses whatever software they want to use but making sure they can all talk to each other in an open way.

We had to decide on a strategy on how we were going to make the change. We decided we weren't going to instantly convert all our current projects and buy new software for the whole company. That would have been too costly. So we decided that all new projects would be done with the new software and we looked at putting together training and new processes for the new software.

It was really welcomed by our staff. They were really enthusiastic.

We're finding that people are really embracing the technology benefits they are being given. They can see the efficiencies of only having to do the drawing once. Obviously there's training required, but everybody seems to have come to grips with it pretty quickly. It seems a lot more intuitive in the way people create their information.

In terms of whether it's worth the money, it's very difficult to quantify. You'd be paying software support whatever system you

were going to use, and using bim software does mean you are working more efficiently.

### TIME FOR TRAINING

It was important for training to happen at the right time. We trained project by project so that the guys could leave the training room and start learning in a live environment rather than waiting three or four months and forgetting what they'd learnt.

We've tried to develop in-house experts so that someone from the first project would be moved on to the second project, so they could share their expertise.

Our next step is to enhance the way we work with other consultants, clients and contractors. We've worked very successfully with some consultants and undertaken a lot of research and development with others. We exchange protocols and look at our bim strategies jointly. We exchange IFC models to look at how we can bring information in and out before we even start working on a project. We've found that it's very much about communication.

Some clients are aware of bim but it's very early days for a lot of people. We are meeting with as many people as we can who share our knowledge that we've gathered this far and asking people to come on that journey with us.

At the moment they're asking for the bim model but not always knowing what they're going to do with it. Some are very switched on and will use it in the way it is intended to manage their facility for the full life cycle. There is extra value in the output certainly but I don't know whether we'd charge extra for that.

I don't think it has changed things too much. The effort curve is brought a lot earlier in the project. There is still a point where we hand everything over. Some of the bim projects we've been involved with haven't necessarily been taken up on by the contractors or the client, but have been collaborations with the consultants. In a lot of cases we're still being asked for a traditional 2D output.

It's not as if we decided we wanted to go into bim and needed to spend half a million pounds to do it. We had a very forward-thinking technology strategy already.

### 11.7 THE BIG INVESTOR



We use software bought by Capita Group and we just pay a use fee, which is an advantage. We have a number of people who have done training courses and they become key people on the projects. We are investing more on projects because most of the work is done up front as opposed to the normal RIBA fee scale so we invest most of our time and revenue on that.

The advantages in bim are really for clients and contractors, so we are investing in the risk they're undertaking by resourcing up front while resourcing for design. We've got more freedom to do that because we're bankrolled by the Capita Group, That's the major advantage that a lot of smaller practices won't have.

With clients looking for more accurate tender prices in this market, having a co-ordinated scheme up front gives a more accurate outcome at the end of the project. Market pressures to pull down costs and risk on projects have been the main driver for our adoption. All new projects from July this year will be in bim.

In fact we have used the principles of bim in its essence for a lot longer. But when we became involved in contractor-led projects on the prison side — taking on the co-ordination of all the work up front, providing the contractors with a co-ordinated building scheme

**Name of practice:** Capita Symonds

**Number of architects:** 246

**Number of staff:** 436 (in the architectural division)

**Practice location:** Eight studios, centred on London, Birmingham and Cardiff

**First use of bim:** 2008

**Software currently used:** Revit, AutoCAD, MicroStation 3D, SketchUp

**Level of investment in bim:** £250,000

**Number of live bim projects:** Eight

**Biggest project carried out using bim to date:**

Belmarsh Prison — £100 million

Andrew Pryke, design director

very early on — we immediately saw the advantages.

With clients looking for more accurate tender prices in this market, having a co-ordinated scheme up front gives a more accurate outcome at the end of the project. Market pressures to pull down costs and risk on projects have been the main drivers for our adoption of bim.

The first full bim project we've done was Belmarsh Prison, which completed about six months ago. We've now got another project on site nearing completion. Part of Belmarsh got Breeam outstanding and the rest got excellent.

It was done by the London studio, which is fairly advanced with its cad skills and in delivery. Getting the right people who are positive and have taken on board the advantages for the team of having this resource means that the process naturally evolves.

What it does mean is that people up front need to know how to build a building, which can't be a bad thing. Every line means something and has a value.

#### BUILDING MAINTENANCE

We have a real-estate and a management division, and the bim model is useful for them to co-ordinate buildings and maintenance in the future. It's an ideal tool to do that.

We are developing a feasibility model that can be taken at very early stages — a building information model that you cost to give you rental values and energy costs for, say, an office block. And we're looking to plug in planning data to give you an idea of the likelihood of winning planning. We are working on the research and development of that with Autodesk.

Once you have made your targets clear from the outset and you're designing up front, the environmental side can be monitored and valued from the outset. You can review everything and see exactly what it's achieving. Once you've got your head around what it's doing — and why it's doing it — it becomes very logical and you think: "Why wasn't this done before?"

The QS role changes because you can cost from the model. So what does that role become? A lot of cost consultants are looking at whether they should become bim managers. It's design driven, so my natural inclination is that it should be a designer leading the bim management side. It needs an all-rounder to drive that role.

#### RECRUITMENT

When we recruited people from Kingston University and the Mac in the past it was mainly because they'd developed buildability skills — they knew how to design and build.

We're looking at what skills people come out of university with, but if someone is bright enough — and most architects should be — they should be able to adapt to new process and thinking. But we do now ask if someone has "bimed" before. It is useful if someone has those skills when they walk in the door.

As architects we are often leading the bim side of projects. We're becoming bim managers now — those skills are becoming more and

more important so if someone has them it would be a real advantage. But I always look for a good designer. If they're bright they could pick these things up.

We send people off for training and they pass it around. We have had a bim co-ordination group for a while and we pass information around the whole group — Capita Symonds employs about 4,000 people.

There are quite a few who treat their cad skills as a hobby — there's always somebody who wants to show people what they can do and pass it on. The majority of our architects are now bim-skilled to an extent, even if they haven't run through a project yet.

A lot of clients are asking for bim deliverables because a lot of them are doing government work. We're doing two large office buildings in Nigeria on the basis that the UK-based client has seen the advantages of the model and they want to reduce the risk.

It's an essential part of the requirement to do the work. We're winning work because we have the skills. Contractors are coming to us because of it and it's a key part of winning work at the moment.

We work in all sectors. Microstation is essentially required by the rail sector, by Network Rail. AutoCAD has been the standard software package for the whole company but Revit is now taking over. I think it's more versatile.

The projects in Nigeria are essentially being done in Revit but our Nigerian partners aren't quite up to speed so that will be moved over into AutoCAD post-planning.

The ideal is to start in one software package and carry on through. That is what we will be doing for all UK projects from July. It just doesn't make sense to do half and half.

## 11.8 THE SMALL PRACTICE

In terms of full adoption, all the BIM projects we're working on



currently are through to planning stage but are at various stages of construction. We've not completed a project with full BIM yet.

It came into the practice because of me. I began to use BIM in the mid-1990s as a student at Birmingham School of Architecture. I've been using ArchiCAD since around 1995.

I used it throughout my architectural education and then when I joined Axis as a year-out student I started to introduce it into the practice. In around 2003 we committed to the purchase of one licence of ArchiCAD and used it sparingly on the occasional project.

It took me from 2003 to 2011 to finally muster the courage to switch the entire office over to BIM. It should have been earlier and that's something I deeply regret.

The challenge for a small practice like ours is the capital cost. It was about having confidence in the body of work we were about to enter into at that point in the year. But also it was about choosing a point at which our staff levels were suited to a switch and to training. In 2011 we had a reduction in staff and we chose to invest in BIM to help us through that reduction in manpower. It has helped very much.

#### IMPROVED DRAWING QUALITY

**Name of practice:** Axis Design

**Number of architects:** Two

**Number of staff:** Six

**Practice location:** Birmingham

**First use of BIM:** 2003

**Software used:** Graphisoft ArchiCAD, SketchUp

**Level of investment in BIM:** £15,000

**Number of live BIM projects:** 15

**Biggest project carried out using BIM to date:** £3.5 million housing scheme

**Interviewee:** Rob Annable, director

Our production levels have improved and our drawing quality has improved. We are ready for full collaboration with bim Level 2 with other members of the construction sector. We're just about to embark on some projects experimenting with that. We have a relatively small domestic project – a whole house retrofit – and we're collaborating with 3D laser-scanning service providers. We are just about to embark on the drawings for a housing scheme in Birmingham and we are hoping to introduce bim collaboration opportunities to the other contractors and team members.

We've made extensive use of bim to improve our research and design work in the Passivhaus field. That's one of many aspects to it. It's demonstrated its benefits in terms of speed of drawing application under pressure for tight deadlines and it's also allowed us to extend the quality of our energy performance assessment.

For us one of the biggest challenges has been using the software on housing layout sites. You might argue that bim is historically aimed at individual building design. It becomes a slightly more complicated process sometimes when you're working across a site with a number of different buildings. Managing that within a model is quite challenging.

There is a very important aspect for debate by the profession. We are producing information that contains more detail in the early stages than we would traditionally have committed to. The challenge is learning how to share and provide or issue that information at the appropriate time for the client.

What I would say about how it changes the way you design is that it is encouraging my staff to consider the physical construction of building elements in a more integrated way and at an earlier stage.

#### PAID FOR ITSELF

It has paid for itself. We made the full switch in September last year. I've not done any work to measure that, but the production of information has improved and we have had more opportunities to win work, so bim has paid for itself already in that aspect.

We started with dedicated training for the rest of the staff supplied by our vendor over a four-day period split into two different events. That's been all that was necessary. Beyond that it's in-house, with support from me, and tutorials and how-to information from blogs and websites. We will need to consider a dedicated period of training for anyone new that comes into the office now, which isn't something we would have done before.

We haven't needed to make any changes to our hardware. That's one of the reasons why I chose ArchiCAD. The capital costs are much less painful with the software choice we made because the training costs are pretty minimal and the hardware costs were non-existent. We will consider a hardware investment to deal with larger schemes, but we've not been forced to change our hardware choices at all.

#### 11.9 THE SOLE PRACTITIONER

I set up my practice in 2010 doing a mixture of design projects and



research projects. The design projects include a feasibility study for new-build residential in London, an art gallery and apartment in Hampstead and an office refurbishment.

The practice's research projects come from my background in housing design consultancy. I work for the GLA on housing research and policy projects and I also do special research into the history of housing design.

I was introduced to bim by a former colleague in 2010 when I started my own practice. We collaborated on a small project and I saw it in action for the first time. Soon after that I bought a copy of ArchiCAD.

I originally bought ArchiCAD SE 2010 and I upgraded just a month ago — I spent about £1,400 on the original programme and a further £800 upgrading. It was a choice between that and Vectorworks, but Vectorworks doesn't have the same capabilities and at the time ArchiCAD was also fractionally cheaper.

The option I use is ArchiCAD 15 Solo — and basically there were two reasons why I was attracted to it. You're able to have very good

**Name of practice:** Emily Greeves Architects

**Number of architects:** One

**Number of staff:** Two

**Practice location:** Westbourne Park, London

**First use of bim:** 2010

**Software currently used:** ArchiCAD 15 Solo

**Level of investment in bim:** £2,200

**Number of live bim projects:** Four

**Biggest project carried out using bim to date:**  
£1.5 million housing development of nine units

**Interviewee:** Emily Greeves, founder and director

control of line weights, text layouts and fonts, and you're able to produce quite good presentation drawings quickly. The bim capabilities seemed very good as well, and it came highly recommended from my friend. I've still got one licence and I share it with my assistant.

I use it in three different ways depending on the project. One is using the software the way it was designed to be used: you build a model using these customisable objects — smart objects. It's an approximation of the actual design created using the options you're given. Then you precisely define each element as a detailed drawing. Working in that way you can very easily rough out a model of a real proposal which is very useful for competitions and things like that.

The second way of using it is to actually model everything — to make a model of all the internal joinery using the specific sizes of elements you're proposing — and I've done that for a refurbishment project and found that to be very useful.

And then the third way is to communicate quickly with a structural engineer about tricky corners in a project - I've done a rough model and emailed images of that over to him and we were able to have a more detailed conversation more quickly about a design that he's less familiar with.

The beauty of it is being able to collaborate with your design team. Not all the consultants I work with regularly have the capability to collaborate on the model or even view the model so it's not really a collaborative tool yet.

All of my clients have been private clients so I wouldn't expect them to know about this. And I don't think it's something that I've told them about actually.

All of my knowledge of bim is self-taught. But I don't think I use all of its capabilities.

ArchiCAD is quite intuitive. It took me a little while to work out the more advanced features but when my employee started it only took him about three weeks to get quite proficient.

It brings efficiencies in terms of the managing of drawing sets and updating drawings as designs change. That's not to be underestimated — it's quite good news for small practitioners.

The government is trying to define bim as a collaborative process rather than a workflow system whereas some architects see it as a drawing tool. I have no chance of getting any £5 million projects so I haven't been following that debate.

#### 11.10 THE ARCHITECTURAL TECHNOLOGIST



Both my co-director and I were health-service architects and we'd been using AutoCAD AEC for a number of years. It was a 3D programme heading in the direction of interoperability. We were finding it a bit restrictive. So many people wanted 3D elements out of it and we found it wasn't suitable so we moved over to ArchiCAD.

We looked at Revit and we looked at ArchiCAD as the two main options and at the time we thought that ArchiCAD was more advanced and relatively easy to learn — although one of the guys in the office is now shaking his head.

Literally one week we decided that was it and started using it on all of our new projects straight away and wound down Autodesk on our other projects. We bought two licences initially — we've got four in total now.

#### SMOOTH TRANSITION

It was a smooth transition. A lot of people worry about that jump, but you've got to immerse yourself in it. It made the workflow a little bit more efficient in some areas and there were benefits in terms of generating visual 3D elements from it.

**Name of practice:** WM Design & Architecture

**Number of staff:** Five — two chartered technologists, two associate technologists, one profile candidate (technician) CIAT, no Arb registered architects

**Practice location:** Menai Bridge, Anglesey

**First use of bim:** 2007

**Software used:** ArchiCAD, SketchUp, DraftSight (SolidWorks)

**Level of investment in bim:** £10-12,000

**Number of live bim projects:** Two

**Biggest project carried out using bim to date:**

£2 million extension to hospital for renal centre

**Interviewee:** Adrian Williamson, director (CIAT practice)

Before, we might have done something in AutoCAD and then might take it into SketchUp, or even the other way round. You were making multiple steps which can always drag in design issues and discrepancies.

I think some of our clients noticed a difference. As soon as they know you are going to give them a 3D output they want more of it. They want the visuals, walkthroughs or whatever.

With domestic projects, if we give our model to an engineer he's not going to make use of it for simple structural stuff. But with larger projects, they need the model or components to run analysis, to run thermal calculations and you've got to be able to provide that.

On one of our projects, a health centre where we're going for Breeam healthcare excellent, in order to do the daylight calculations and thermal modelling they need a model to work on and any component data that goes with it – the thermal values for the various elements. It is far harder to do those calculations in a more dumbed-down format.

Unfortunately, there are a lot of people out there who see bim as just 3D. It's quite a lot more than that. A lot of structural engineers don't want a 3D format. It's going to take them a while to adopt it fully.

#### TRANSLATION PROBLEMS

There's always an issue about interoperability and translation of information. What you need on the other side is for the M&E engineer or structural engineer to be able to receive the model data and use it.

People are still taking that data and dumbing it down and you lose some of the information. It really depends on all parties involved having some form of bim software. For small to medium practices the likelihood of them having a design team like that is very slight.

I would certainly say it's saved us time with certain things. It takes a bit of time to adopt, but the output is certainly improved. You're able to notice errors either in elevations or plans when you make other changes.

I think it has paid for itself. There are some projects that I don't think we'd have been able to do if we'd done it the old-fashioned way. Certainly a bit of terrain modelling is quite handy. One of our health centres is on a sloping site and it's allowed us to model the building onto the site which we couldn't have done easily with 2D.

The biggest benefit, I think, is the additional output that you can get from it – generating schedules directly from bim software, rendered images, that type of thing. You don't have to buy companion software to do all of that, it's within the programme. And that's the same with all of the bim software that's out there.

#### LEARNING PROCESS

I don't think it's hard to learn. We have GCSE students that come in for a week over the summer and they can learn it in a week.

We don't talk directly to Graphisoft. Because we haven't had

massive projects, I suppose we're only just scratching the surface of it. If we had a larger project I do think Graphisoft would be there to assist.

We did a little bit of self-learning. Out of the box you can get so far. But then we did a two-day course with a company called Applecore and that was enough to get you going on a scheme.

We first started using bim on Windows XP but recently we changed to iMacs throughout the office. We didn't upgrade the computers because of it - we wanted to go down the Mac route anyway. We've recently upgraded servers and things like that. It's common sense to future-proof yourself a little bit and buy the largest you can get, but we haven't been forced to - it was our decision.

You can't sit still. You have to keep moving with the times. I think if you just sat and used the same old software you'd be left behind. With the recession you've got to keep pushing yourselves.

There are hidden benefits in bim that some practices may not appreciate fully. I think people respect you if you produce a reasonably decent and tidy output. If you're providing a minimal service, people may not come back to you. If you can provide a little bit more as an added benefit then clients and contractors will appreciate that.

## CLIENT CASE STUDIES



## 12.1 MANCHESTER CITY COUNCIL

**Interviewee:** John Lorimer, capital programme director

We've been interested in the concept of bim since 2005. It's really started to get off the ground in the last few years and it is now really important to us. We've got four projects that are using bim in different forms now.

The project we're putting the most resources into is the Manchester Town Hall extension and the Central Library [designed by Ryder Architecture and Ian Simpson Architects]. It's a £100 million refurbishment job.

We didn't ask for bim to be part of the offer from the architects, but once Ryder had won the job they asked if it would be OK if they used bim. And we said "bloody right".

Ian Simpson Architects weren't using bim but they saw very quickly what it was doing for the Ryder people so they started to use it.

### UNIVERSITY RESEARCH

We did some research with Salford University to see how we were doing once we'd got the contractor on board — we're very much at the beginning of this and we're discovering that there are some problems, like getting the different models to talk to each other. In some instances the models actually haven't talked to each other.

We're putting the most effort into working out what we can get out of the model at the end of the project from a facilities management view when it completes in 2013. That's a challenge the whole industry faces: to have something useful beyond the completion of the job.

On another of our projects — a local-authority new build of 173 units — we talked a lot about whether we should use bim. It's a project that's shared by two contractors and we put in £100,000 to pay a third-party provider to get bim as far as we could into the project. Very quickly we grossed £250,000 back through more efficient design and a quicker programme. We covered the £100,000 investment pretty well straight away, which is a simple benefit.

Now we're looking to use it on a very small project in the old town hall, of less than £50,000 — just to see what happens.

Bim is the only way forward and we're very keen to be part of getting it used in a meaningful way.

### BIMBOOZLING

There's a lot of bimwash, or bimboozling, and I think that's quite a big issue for clients. The public and private sectors are all being urged to adopt bim or told that it will be part of the delivery of their projects and there's some real learning to be shared about what it really means.

We're in that tough stage where awareness is there but we are all asking "what does it really mean and what do we have to do?" I don't think anyone has the answer to that.

For us it means that more of our people have to be trained in the use of the software to be able to use it at the facilities-management stage.

But 90% of the challenge is cultural and nothing to do with software. It's about how we integrate the supply chain into it and how the different professions settle down into their new roles – and I am convinced they will be new roles. In the space of six months I've seen some QSs get hold of this and start to talk about where they can add some value to the process.

## 12.2 GREAT PORTLAND ESTATES

**Interviewee:** James Pellatt, head of projects

We're using bim on a number of projects. There are three principal reasons: quality, programme certainty and facilities management and the ongoing benefits of that.

We really care about the quality of our buildings and we will do anything we can to improve the physical appearance and operation of a building. We've always tried to be at the forefront of thinking in terms of construction. In the current economic environment, there's a lot of single stage contracting going on which is very good for delivering price certainty but not necessarily quality.

## 240 BLACKFRIARS ROAD

In UBM's new offices on Blackfriars Road [240 Blackfriars Road, due for completion in 2015] we've gone along a two-stage construction tender route because we want to improve the quality of the design chain. But then the question is how to avoid being taken advantage of in terms of costs and the packages that come back to us. The way to do that is to co-ordinate the information before we agree a contract price.

The architect is AHMM and we've got Hilson Moran as engineers and Adams Kara Taylor. When we decided we wanted to deliver the project using bim, the design was already at stage D/E and it was in 2D.

It was difficult to go back and implement bim – because the building hadn't been designed in 3D the architects weren't keen to go back and reinvent their work. So what we decided to do was engage with an independent bim facilitator to take the 2D information from the architect and the 3D model from the engineers and co-ordinate it into a single model.

The benefit is that we've been able to look at the design independently and point back to the design team when we find things haven't been properly co-ordinated. It takes a lot of the emotion out of it. When it's there in black and white it takes the debate out of it and it just becomes about what to do to remedy the issue.

The geometry of that building is very complicated and in order for it to look as crisp as it possibly can by the time we come to build it the quality of the detailing should really shine through.

AHMM can really see the benefit of it themselves now.

The other key point is that the financial savings that bim will hopefully generate mean that we are able to invest in quality of finishes elsewhere in the building which is something the design team can respond to. That's been really positive.

We are trying to make sure that all of the contractors can now buy into bim. We're issuing 2D information but it's always based on 3D information and the contractor sees the benefit of it. We've asked that we get the model back at the end of the contract to use it in the management of the building. The occupant will be able to use it for their own fit-out. We'll use it for operation and maintenance of the building. The ongoing operation is important to us. As much as we want you to occupy a beautiful building we also don't want it to have problems when you're in it. It's our aim to make it operate efficiently.

#### DESIGN TAKES PRIORITY

We don't think that bim is just a co-ordination and construction tool. We independently own that model rather than relying on the contractor or design team and it will help us deal with the nagging problems we have with PI.

We employ people for their design ability first. On our Rathbone Place project we have appointed Make Architects after a competition. We asked them about bim during the process, but it was a design-led decision. We enjoy working with good designers. We would want them to develop bim skills because we share the same objectives for the quality of the building, but we find that our designers are buying into that any way so they are getting to it.

The overriding thing about bim is that it's not a panacea. It's not the answer to everything. You're just highlighting problems earlier. You still need to invest heavily in your design team. We would invest in good design first and then bring the team along with the bim programme afterwards.

For the next few years we will rely on independent validation. As the industry gets used to bim it will be less important, but I don't think architects have the blanket skills in-house yet to be able to fully achieve it.

I still think there's an issue with architects taking engineers' models and then giving them back to us — legally and with insurance — and I can't see that being settled quickly. So we still need that independent assessment.

## CONTRACTOR CASE STUDIES



### 13.1 KIER

**Interviewee:** Graeme Forbes, managing director process and engineering

The starting point for us with bim was probably when we became involved in multi-disciplinary design and build about 12 years ago.

We quickly realised that the problems in the delivery of design largely come down to two issues. One is being able to properly see and understand what it is you are supposed to be delivering, and the second is around the flow of data that takes information from design into schedules and procurement and right the way through to final handover to the client.

It is traditionally a very fragmented manual process that is heavily reliant on tools like Excel. So we set about trying to solve both of those problems.

Our attention was focused on trying to take make use of the underrated intelligence in the cad environment and using it to help establish an automated flow of information through the project. We never called it bim, but it was one of those eureka moments where you sit with the people at the sharp end and see what they do and then connect the dots together and realise that there's a flow of data available to us that we could capitalise on.

We quickly started to realise some of the benefits – and to some extent some of the intangible gains – that come from having control of data as a single source alongside a single visual environment. We then created the process flow and used it to help drive more collaborative working.

### CENTRAL AFRICA

The first big project we tried it on was a job we were doing in central Africa, which was almost the riskiest type of project we could pick, but the drive there was to make sure that whatever we were going to ship into country could be right first time and that we'd be able to communicate properly with everyone involved.

Fundamentally it was the right approach - our toolsets allowed us to communicate in a visual way with everyone involved in the job. The limitation then was more the technology than the behaviour. These days it's more the behaviour and whether people want to change than the technology.

In the environment we're in at the moment there are so many obstacles to changing the way we work for the better that unless somebody like the government says "you must do this" then people end up with too much choice.

### INTEGRATED PLATFORM

We now have a sophisticated integrated platform that allows multiuser secure access to truly collaborative working around a single source of truth and a single model. Although we probably sit close to that fine line between an open and closed bim system, our environment is as much a portal to the other bim software that other people might want to use.

Although we might be perceived to have a closed system as a platform, our toolsets interface with many of the other pieces of bim software – so, if anything, we’ve made something that’s easier for SMEs to use and interface with us.

We are doing a lot of in-house R&D and trying to foresee the endgame of a truly beneficial bim-driven environment with a scalable business solution. A lot of solutions at the moment are really very dependent on skilled use - knowing how to use the tools properly. We’re trying to get to a situation where the level of entry is lower but the value that comes out is considerably higher.

### DEMANDING CONSISTENCY

Like many others, our approach is driving us to be more prescriptive about using bim and how we want it to work, although we are quite flexible about the way the model is set up – providing it is set up consistently.

The worst thing about bim is when people work inconsistently. Lots of architects, for example, use bim as a means of producing better drawings rather than enabling a data-management process. You only need to look at the COBie drops that are required as part of the government initiative to know that you’ve got to treat bim as the start of a data-management process and not as a drawing aid.

There are bound to be levels of frustration as we try to move into a new dimension. But we’re trying to make a more effective process for everybody and, with the best will in the world, that is likely to make us more aligned with certain organisations if they work well with what we’re doing.

If others see the benefit of working the way we’re working, it will of course be of benefit for us to work with them.

### 13.2 SKANSKA

**Interviewee:** David Throssell, BIM technical manager

In 2008 our CEO mandated BIM. So In Skanska we had our own BIM mandate in effect from 2009.

I was asked to become part of a BIM implementation team within Skanska to meet this challenge And it was a real challenge, because we were asking, what is BIM?

Our definition of BIM is not necessarily all about 3D CAD. We like to say it’s about delivering the right information to the right people at the right time.

The 3DCAD model then becomes a route map through the various data bases and data sets on the project. We want our designers to build intelligent 3d models and keep them fairly lightweight in terms of what they add.

Some people get very excited and carried away with the potential of 3D, but it is possible to put too much detail into a model. We try and encourage our architects to use generic objects as much as possible. We give them no more than four or five attributes to add to their objects. All we need are those attributes that help us find information.

We talk about referenced and related info. We want the 3D models to host the minimum amount of info and reference out to other databases in the system as much as possible and if necessary link out to the internet for other information. So the model becomes a graphical user interface for all of the systems and databases we normally have on a project.

We use ArtrA to link the model to our document management system so that if we click on an object that represents, say, a hospital room we can fire a live query to our document management system. We can send a query to the room data sheet data base. We can use the system to do progress recording. We can use it to record snags and outstanding work. We've developed a tablet PC system that joins all this data that our architects have created for us. All this uses proprietary software; we've just paid people to develop the glue between the software and the databases.

#### MODEL SHARING

We find that architects are concerned about sharing data and sharing their models. I'm never quite sure why. In the past they've been happy to pass on drawing files in their native file formats, and what's the difference between 2D and 3D? We only want them to share that information to drive out error in the design and build.

We take the view that everybody owns their own bit of the model. Our design agreements are written to make it clear that designers licence their data to us on a project - it's not ours as such. The copyright remains with them. We are interested in the intelligent version, the 3D model that we can browse and that has all the attributes that we've asked for. It's the read-only version. We're not there to change it and mess about with it, we're there to reuse it and share it.

We're not that bothered about the native format of the file. What we want is the rich read-only format - IFC, Bentley i-model or Autodesk NWD. That format drives our BIM system and makes this 3d model the route map for all the databases and data sources on the project.

#### VALUING DATA

Data is the new deliverable. The government, with its BIM mandate, is making it very clear that it values data and is willing to pay for it. That's an important message to the construction industry. In the past, architects and contractors haven't valued the data that we have created routinely but not made a great deal of use of.

We measure our BIM implementation against four areas: people, process, technology and projects. We have found now we are almost three years into the journey is that the people issues are the ones that are the most difficult to tackle.

When architects jump from 2D CAD to 3D CAD, they sometimes still have the mindset that they're modelling in order to generate drawings instead of modelling in a way that helps us build. Often we find that we have to go back into models and re-edit them which

we don't want to do. We want to share and reuse data and add to it, not redraw and re-key because that's where ambiguity and errors creep in.

#### NEW DELIVERABLES

It's important that we get people to understand the new deliverables; that a drawing is no longer sufficient for us. We expect our design teams to deliver spatially co-ordinated information. We expect architects to act as the lead designers and we pay them to do that. The only time we want them to come to us with clashes and conflicts is when there is a problem that can't be resolved within the existing design team.

We've found that projects benefit the most when you find champions who are prepared to use the technology and engage with the process and when others see them use it. That generates a lot of interest. We concentrate on training the trainer.

Next week we have 25 of our key supply-chain partners, including architects, coming to our office for a 2 day BIM session. We've got to bring everyone along on our journey. We can't throw out a list of requirements and just expect our architects to deliver.

We're still saying come and join us. But we are rapidly going to get to the point where we have a critical mass of practices that we work with who can deliver what we want and are happy to work together with us.

The other thing architects are interested in is what happens to design fees. I think it's an opportunity for architects to add greater value. Some clients may be looking for lower design fees, but others might be looking for more options. I think there's a trade off.

APPENDIX



## **I. RELATED ARTICLES FROM BD**

### **i.i How will investing in bim affect your tax bill?**

By Mark Twum-Ampofo

Published 24 February 2012

Whether you make the leap before or after the end of March could make a difference

While the cost of bim software will vary according to an individual practice's requirements, it is fair to say that it represents a substantial outlay and one that could have greater financial implications from April.

Because the software will be used for a number of years it represents capital rather than revenue expenditure. This is important because of the way in which companies receive tax relief on their spend.

Until the end of March, practices are entitled to an Annual Investment Allowance (AIA) enabling them to claim full tax relief on the first £100k of capital expenditure in a year. That means that for most architects the cost of purchasing bim software will be set against profits in the year of purchase.

However, from April the AIA will decrease to £25,000. While the cost of bim software may well fall within this reduced allowance, you also need to consider all other capital items purchased in the financial year – such as laptops, iPads and desks – which together could take you over the £25,000 threshold.

The excess will be eligible for capital allowances which is a far less generous regime and only allows a firm to write off 20% of your expenditure against profits each year.

Cash flow permitting, practices expecting to make the move to bim in the near future should consider whether it would be beneficial to make the investment before the end of next month in order to accelerate their tax relief.

### **i.ii How to avoid the problems with bim**

By Martyn Day

Published 6 June 2011

Bim is trumpeted as the one-stop future of construction, but the reality is not as simple as it seems

The marketing engines have been promoting bim as the future for a number of years without actually delving into the detail. However, even the most committed bim convert will relate initial drawbacks to implementing process change and making the switch. There will be hurdles to overcome and new problems to deal with that really should be examined and understood before any fresh implementation is considered.

## **THE DEMO VS THE REALITY**

Bim is presented as a one-stop solution. Simply build a single, data-rich model and everything will be produced near automatically

- plans, sections, elevations, quantities, renderings, costings and even perhaps the energy certification. It is a utopian vision.

The actual single model is really a dream. An architectural bim model is quite different from a construction bim model - while the geometry may be the same, the information is different

and the construction scheduling requires elements to be broken down (eg how many concrete pours for the floor). Companies like Tekla create models for constructability and fabrication, with the corresponding detail. Vico also creates bim models for quantity, cost, scheduling and production control.

#### DEALING WITH CHANGE

The workload changes and shifts forward many design decisions. Before starting a project, new “families of parts” (intelligent components) should be created, which may bring forward decisions on interior fittings such as doors and windows, escalators, lifts and glazing. The level of detail in the model is also highly important - too little and the benefits of modelling would be lost, too much and the model will become too big to load and manipulate. Medium to large buildings need to be “cut up” to be manageable.

#### ADAPTING OUTPUT STYLES

One simple problem is that the automatic output of 2D plans, sections and elevations has a style which many firms do not appreciate. Customers expect drawings to conform to their own internal standards. Many send these through an AutoCAD user to “tart up” and lose one of the big benefits. Any changes to the model will update the drawings and these will all need to be hand-edited again.

#### CULTURE CHANGES

Changing a long-established way of working is always going to cause problems and bim has its own issues that need addressing. Obviously there is the “people” issue: staff skills need to be upgraded and new staff will need bim understanding. Internal processes will change and new teams will be built. Most bim tools are “easy-in” but the devil is in the details and there is a fairly steep learning curve.

#### INDUSTRY AND DATA STANDARDS

Standards are a major industry issue. First there are internal standards and then there are the data exchange standards. For the internal standards, a workgroup has defined the AEC (UK) bim standard, a template to be downloaded and incorporated into an office’s protocols. The standard has no legislative backing and is unfortunately biased toward Revit users.

The cad industry has always been terrible at data exchange. With bim, it appears that the competing software players are taking interoperability to new lows. Bim models have complex 3D geometry, behaviour, parametric and lots of information attached to each object and the only real standard is IFC (Industry Foundation Classes).

This is an independent documented standard, which the vendors interpret and implement at their leisure. The end results are hit and miss, but IFCs are the only real hope and one can only wish that this improves. For now a number share data through the 2D drawings (DWG and PDF).

## CONTRACTS

The last cultural issue is of course the contract situation, which does not account for the levels of integration and data-sharing that bim enforces. A new type of contract is required when tackling projects as the overall liabilities must be shared. Bim favours design builders; traditional federated projects require a new attitude to liability of deliverables.

## UPGRADING HARDWARE

Depending on the software, bim models get big, fast. David Light from HOK told me the firm is stipulating 24GB of ram for its new workstations so they can hold the Revit datasets without paging to disk on their biggest projects. This is a considerable investment: you simply cannot run bim on old machines designed for AutoCAD or VectorWorks. Other bim modellers are not quite as memory-hungry but still start to swell as the model detail grows.

Finding like minds

Another obstacle is that, if you are using bim, it pays dividends to work with firms of a similar mindset. With the interoperability issue, it helps if you are on the same system - Revit Architecture to Revit MEP or Bentley Architecture to Bentley Structural. With bim still in its formative stages, adoption is thin on the ground, especially within the MEP industry. As adoption accelerates, this will become less of an issue.

## CONCLUSION

Building information modelling is widely seen as the next technology for the building industry and rightly so. But adoption will require adaption, investment and greater teamwork between the core trades. A variety of issues still need to be overcome both in the technology and between developers. Experience suggests that after three projects most firms really see the benefit of the move to bim but there are also failures, albeit co-ordinated ones.

**Martyn Day** is editor of AEC Magazine, a bi-monthly journal for construction professionals.  
www.aecmag.com

### **i.iii Bim adds an extra dimension**

By Hugh Davies

Published 15 October 2010

Political advisers may be pushing building information modelling, but is the industry ready?

Although the use of virtual 3D building information modelling (bim) has been widespread in the aircraft and automotive industries

for many years, the construction industry has been slow to take it up. Paul Morell, the government's chief construction adviser, recently urged a move to the adoption of bim to reduce cost and add value to public sector building procurement.

Today, architects routinely use 3D modelling to provide rendered views and walk-throughs of design work in progress. It is essential for pitching ideas and communicating with clients. In addition, 3D modelling is often used at the production information stage for structural design and analysis, cladding packages or the detailed resolution of specific 3D geometries. However, these uses of 3D are often bolt-on additions to production information, which usually remains as a set of 2D abstractions of the building in plan, section and elevation. Such 2D information requires a combination of overlay techniques and human skills in coordinating and interpreting the information throughout the construction process.

Bim aims to be fundamentally different, in that its approach is to use a virtual 3D model of the entire project, from which all 2D and 3D information is generated. This can vary from conventional 2D plans, sections, elevations and component schedules through to client-friendly visualisations and computer-aided manufacturing (cam) models.

The concept is that, since all the information stems from a single 3D model, it is all spatially consistent and coordination errors can be eliminated so that the client can have updated 3D visualisations as soon as any changes are made. The completed 3D model is also seen as the ideal vehicle for the repository of as-built information for facilities management over the lifecycle of the building.

So how does it stand up in practice? As a concept, Bim has been around for a long time. I remember being shown the then in-development, now defunct, Gable software at Sheffield University more than 20 years ago. Leading software houses currently have their own particular flavours - Autodesk's Revit, Bentley's Architecture v8i and Graphisoft's Archicad. However, bim is yet to transform the UK construction industry.

The organisation Constructing Excellence in the Built Environment is apparently due to publish a report recommending the use of bim in building procurement.

The real-world usage of bim doesn't always match the theoretical ideal

The flavour of UK bim usage is indicated by five bim deployment case studies that they published earlier this year (<http://tinyurl.com/2vdqf8a>).

The five illustrated projects were spread across health, education, commercial and scientific sectors with contract values from £30 million to more than £300 million and all completed within the last five years. They indicate that the key benefits derive from the single source of information leading to better "first fit" spatial integration. This seems to be particularly the case in detailing between different design disciplines. These advantages are credited as leading to reduced requests for information from the construction team, fewer changes by the design team and consequent reductions of up to 10% of the overall budget.

However, what is also apparent is that the real-world usage of bim doesn't always match the theoretical ideal. Despite the adoption of bim on projects, not all parties take it on. Even where professionals

subscribe to the use of bim, internal design development work is often still executed in 2D.

The single most specific virtue of bim - the use of a single, central information source - does seem to create its own issues. On the micro-level, difficulties seem to arise when changes to the single, central bim model made by one party are inadequately flagged up to other team members. While, on the broader level, parties to the process have concerns about ownership, access and design liability for the single design model. This seems to act as a restraint on its effective transfer from design team, to construction team and end-user client.

Bim is undoubtedly a powerful tool in the armoury of the building designer, but is it a panacea for taming the construction procurement process? Unlikely. It is easy to find examples of how the use of bim has saved time and money on construction projects, but architecture is more than the sum of the resolution of envelope, services and structure clashes.

For many, bim remains just one tool among many. Encouraging a much overdue increase in its usage amongst architects is desirable, but is the imposition of it on the design process from the client side really going to be the best way of achieving this?

**Hugh Davies** is a co-founder of IT consultant Lomas Davies

## II. RELATED ARTICLES FROM BUILDING

### ii.i Bim and legal issues: Model behaviour

By Rudi Klein

Published 17 February 2012

Last year Building briefly reported on the first claim to arise in the United States from the use of Building Information Modelling (bim). It concerned the construction of a university life-sciences building. The architect and M&E consultant had used bim to fit the engineering systems into the roof void of the building. The space was very limited; the installation could only be carried out if done in a specific sequence.

Somebody had forgot to mention this to the contractor. He had completed 70% of the work before realising that the rest of the installation would not fit. He claimed against the client who, in turn, issued claims against the architect and consultant. Eventually a settlement was agreed in favour of the client with the contractor, architect and M&E consultant each contributing to it.

This kind of dispute could, of course, occur on any project irrespective of whether or not bim was used - it was not linked directly to the use of bim. One can only speculate, however, as to the reason why the modelling process did not simulate the sequencing of the installation or, if it did, why the contractor was not aware of this.

The industry will not rush to invest in bim training and technology if it is introduced into traditional procurement processes that are now primarily aimed at facilitating risk dumping

In a case such as this the key question would be: who had assumed the risk that the installation would not fit into the roof void unless carried out in a specific sequence?

Obviously, the answer would depend upon the wording and type of construction contract used but, in this country, such risk would lie with the contractor more often than not.

But I can imagine a similar problem here. For example, the M&E contractor is presented with a consultant-designed model of the building (or section of the building). He is then told to complete the design and carry out the installation in accordance with the design intent as represented by the model. In the present state of the law the contractor is likely to be responsible for any shortcomings in the design he has inherited via the model.

In *Co-operative Insurance Society Ltd vs Henry Boot (Scotland) Ltd* (2003), Judge Seymour held: "Someone who undertakes, on terms such as those of the contract ... , an obligation to complete a design begun by someone else agrees that the result, however much of the design work was done before the process of completion commenced, would have been prepared with reasonable skill and care." (emphasis added)

In fact, contributing or inputting to someone else's model could, unwittingly, saddle you with extensive design responsibility. If, for example, a manufacturer has supplied data relating to his product, this could require a re-decision of other elements. He could be lumbered with liability for such re-design without having any PI cover. The industry will not rush to invest in bim training and technology if it is introduced into traditional procurement processes

that are now primarily aimed at facilitating risk dumping. Moreover there is concern that many firms in the supply chain will only discover late in the day - that is, after they've been appointed - that their project is bim-enabled. Another, more likely, scenario is that the tender information will simply state: "Bim is a requirement on this project." Everybody will then be left wondering what this means. The government regards bim as a collaborative tool for eradicating waste and inefficiency in the delivery process - not as a tool for perpetuating it.

So, what should happen? Project participants - client, consultants, contractors, FM firms, manufacturers - should, at the outset, agree a bim implementation plan.

The plan should address matters such as:

- what models are to be created and by whom and for what purpose (that is, what are the intended outputs);
- definition of the content of each model and level of detail required from each participant at specified milestones;
- how any conflict between model content is to be resolved;
- levels of reliance that can be placed upon the data content of models and at what stage in their development;
- the software platforms intended to be used, processes for transferring and accessing model files and file storage location;
- ownership of model(s) and data inputs;
- management of the modelling process.

This is not intended to be an exhaustive list. But the overriding factor is that all participating parties should have had the opportunity, as a team, to discuss and agree the content of the bim implementation plan. Then everyone should know what is expected of them.

This is, after all, simple common sense.

**Rudi Klein** is a barrister and chief executive of the Specialist Engineering Contractors' Group

## ii.ii The rise of the bim consultant

By Thomas Lane

Published 4 November 2011

With its clear government backing and success stories in the press, construction firms realise that bim is a Very Important Thing. The question is, how to do it? Thomas Lane meets the new wave of bim consultants who may have the answer

In an office in London's Bloomsbury a phone starts to ring. The caller is a contractor wanting help to win work because he read a story in Building magazine detailing how Laing O'Rourke's use of bim was "key" to it winning the contract to build the Cheesegrater. The office belongs to a firm called Bim Technologies that has only been in existence for two months - it was set up to cash in on the construction industry's need get up to speed with building information modelling. "These stories are great for us," says Rob Charlton, chief executive of architect Space Group, which is behind Bim Technologies. "When the Cheesegrater story was published our phones started ringing, as people saw bim as a way of winning jobs."

The boom in bim is caused by two things. Bim improves efficiency, meaning firms can do more for less, which is essential in today's tough economic environment. The second reason is that the government wants Level 2 bim to be compulsory on all public sector projects by 2016. Level 2 bim is where project teams collaborate using 3D models featuring "intelligent objects", whereby any object in the model, say a door, includes attributes such as cost, fire rating and what it is made from as well as dimensions. According to Mark Bew, chairman of the bim industry working group and director of business information systems at URS/Scott Wilson, only 15% of jobs are currently using Level 2 bim. That means the industry has got a lot of catching up to do, a market opportunity that has spawned a whole new sector: the bim consultant.

#### THE CONSULTANT

Bim consultants come in all shapes and sizes starting off with people who simply take 2D drawings and turn these into 3D bim ones. At the top end are firms offering a far more sophisticated service. They get involved with clients at the beginning of jobs, identify their objectives and develop a bim strategy to suit. This is centred on developing fully integrated teams and ensuring information is created and managed efficiently. The big multidisciplinary consultants have been using bim in this way for some time, so providing a dedicated service is a natural next step for them. Arup is about to launch a dedicated service in the UK and Bim Technologies was launched on the back of Space group's experience with bim. WSP has offered the services for two years and Atkins has helped organisations with bim for the past six months.

The first step is to find out what the clients want. If they want to use bim to operate and maintain their building this needs to be stated up front so the right information can be collected and incorporated into the model. Other questions include whether the model will be used to manage scheduling and costs. The key is only to incorporate essential information otherwise the whole process can get bogged down. "People need to understand everything they are putting into that model and what it is there for otherwise you can slow everything down and cause a lot of stress to the participants," explains Michael Beaven, the Arup director charged with rolling out the firm's bim consultancy service in the UK.

Part of this process is examining what software tools people are using and how these will work together. Beaven stresses that software is very much a secondary issue. "It's about asking the clients the right questions and thinking about what they need rather than what suits the software vendors," he says. "It's a process not a software platform and how that process is brought together can make or break a project." From here the devil is in the detail, a collaborative process has to be agreed on as well as what protocols will be used for data management and distribution. Beaven says

it doesn't matter whether a single model is shared by the project team or they all work with their own models and update these against the others providing everyone uses agreed protocols.

## THE PROCESS

A key challenge facing bim consultants is getting firms that are used to working on their own to collaborate and share information. Anne Kemp, Atkins' technical director for integrating digital solutions, says culture change is one of the biggest challenges. "This is such an important part of rolling out bim and a lot of coaching is going to be needed," she says. "You need to make people feel they have ownership and control of the project. If you can show them what the benefits of working this way are you can win them over and they develop enthusiasm for it." Kemp is doing an MSc in coaching and cultural change to help with this process.

Some client firms find it impossible to make the shift. Arup has been offering a bim service from its Sydney office in Australia for a year. Stuart Bull, Arup's Sydney bim co-ordinator says the firm has had to walk away from the new Louvre in Abu Dhabi. "The client wasn't prepared to listen to us so we pulled out," he says.

Clients are most likely to use a bim consultant. "The people who have the most to gain are the owner occupiers as they have a long-term interest in the building," says Beaven. Atkins says two thirds of the organisations that use its services are public sector clients, but contractors and specialists have a need for a bim consultant too. WSP is currently helping a contractor working for airport operator BAA. The contractor is experienced with using bim but needs specialist advice to make its systems BAA friendly. "The reason I have been asked to do this advanced service is to ensure the information BAA receives suits their methodology, data structure and protocols, down to the right software to use and export it to BAA in the right format," explains Marc Walker, WSP's bim development manager. Bim Technologies has been also asked to turn an architect's design into a bim model by a specialist facades contractor.

Could bim consultancy be the next big thing? "It's the fastest growing part of our group at the moment," beams Charlton. Kemp agrees: "From the point of view of a standalone consultancy I do see it becoming a significant part of Atkins' business." Arup's Australian bim consultancy has been busy too - in the past year it has bid for 34 contracts and won nine, which Beaven says is a good hit rate. But Bew sounds a note of caution saying bim consultancy in its current form may have a limited shelf life. "I don't see this as a long-term situation," he explains. "As bim becomes a more normal way of working and the tools mature, people will be able to do it themselves."

### II.III Bim and the QS: Better late than never

By Erland Rendall

Published 24 October 2011

The recent RICS survey into the engagement of quantity surveyors and building surveyors with bim revealed that a vast majority - nine out of 10 - are either not using or are infrequently connected to bim. David Bucknall, chair of the RICS QS and construction professional group, believes this is a "wake-up call" to its members. The question becomes are the respondents just inherently scared of change or are there more deep-rooted concerns around the impact that bim will have on this profession?

Through his position as chief construction adviser and chair of the government construction board, Paul Morrell OBE, a proud chartered QS and respected leader across the industry, is mandating the use of BIM on all public sector projects by 2016. So with Egan, Latham and now Morrell driving culture change through the industry, why are QSs the last to come to the collaboration party?

Perhaps it's the perception that bim is based around design and design software? This argument misses the point of bim, which seeks to build virtual models and resolve the majority of issues prior to construction and operation of that asset. Cost and programme are key performance indicators, in addition to quality. With the advent of parametric modelling (which forms a model from a set of bases or parameters that are related, such as area efficiency ratios and cost parameters), the QS can contribute these two fundamental parameters to the modelling process from the outset and add the most value from the earliest stage.

The QS can design and set the standards - they just need to think in a different way and work with the other actors in the process. The public sector requires robust and coherent benchmarking and who better to provide this than the QS. Furthermore, the private sector will also demand this commercially advantageous knowledge. The QS will be able to define what "good" is, echoing Morrell's mantra of "good, is good enough".

Maybe it's the threat of Quantity Take-off (QTO) within the model? This means that quantities can be extracted automatically based on the attributes of objects within the model. For QSs to be wholly reliant on "process" to demonstrate professional value is a weak and flawed position. QTO will provide a new and efficient process which will release the true professional QS expertise of determining holistic value and context to design intent and client requirements. Paraphrasing Henry Ford, we will be introducing a whole new method of professional service delivery not just breeding faster ways of measuring.

inally, the current economic climate is being cited as a good reason not to embrace change, innovation and investment in bim. I disagree and suspect that this is more symptomatic of the inherent personality of QS professionals. In reality, there is no better time to engage and realise the productivity gains that bim provides - for consultants, clients and end-users. In a market where "more for

less" is the norm and competitive advantage is hard to come by, bim, and the whole ethos wrapped around it, presents that opportunity for sustainable business growth.

If the profession does not change and adapt, the early adopters in the contracting market will continue to realise the market opportunity and squeeze out the consultant QS. Where is the pride in the training and education that QSs have undertaken, the two to three years of post-graduation experience to then become professionally qualified? QSs have had an identity crisis for the last few decades, ever since the notion of pre-contract cost modelling and estimating entered their skillset. Now is the time to be confident in our ability to inform both the client brief and design concept with the data, information and knowledge that we hold. We can be transparent and share in real-time while leading in an environment where "absolute value" is the highest and most appreciated commodity within the market.

**Erland Rendall** is head of thought leadership at Davis Langdon, an AECOM Company

### III. RESOURCES

#### FURTHER READING ON BIM ADOPTIONS AND STANDARDS IN THE UK:

UK Government website - <http://www.bimtaskgroup.org/>

UK Government Reports - <http://www.bimtaskgroup.org/reports/>

COBie - <http://www.bimtaskgroup.org/cobie-uk-2012/>

COBie data drops - <http://www.bimtaskgroup.org/cobie-data-drops/>

UK BIM Forum (recently launched) - <http://www.bim.co.uk/forum/index.php>

National BIM Library - <http://www.nationalbimlibrary.com/>

CPIC - <http://www.cpic.org.uk/>

New Uniclass Proposals - <http://www.cpic.org.uk/en/uniclass/new-uniclass-proposals.cfm>

B/555 - <http://shop.bsigroup.com/Browse-by-Sector/Building--Construction/Building-Information-Modelling/>

BS 1192:2007 (requires purchase) - <http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030163398>

AEC (UK) BIM Standards - <http://aecuk.wordpress.com/>

NBS bim research and publication - <http://www.thenbs.com/topics/bim/index.asp>

Further reading on bim standards in Europe:

Senate Properties bim requirements - <http://www.senaatti.fi/document.asp?siteID=2&docID=517>

BuildingSMART openBIM - <http://buildingsmart.com/openbim>

#### FURTHER READING ON BIM STANDARDS IN SINGAPORE:

Singapore Particular Conditions for Building Information Modelling draft - [www.aces.org.sg/pdf/058-2012\\_DRAFT\\_BIM%20Conditions.pdf](http://www.aces.org.sg/pdf/058-2012_DRAFT_BIM%20Conditions.pdf)

Singapore bim guide draft - [www.aces.org.sg/pdf/058-2012\\_DRAFT\\_Singapore%20BIM%20Guide.pdf](http://www.aces.org.sg/pdf/058-2012_DRAFT_Singapore%20BIM%20Guide.pdf)

#### FURTHER READING ON BIM STANDARDS IN THE USA:

Contract examples - [http://info.aia.org/bimsample/091708\\_\\_E202-2008\\_\\_eSample\\_\\_Blank.pdf](http://info.aia.org/bimsample/091708__E202-2008__eSample__Blank.pdf) and <http://www.agc.org/galleries/contracts/301.pdf>

The NBIMS National Bim Standard - [www.wbdg.org/bim/nbims.php](http://www.wbdg.org/bim/nbims.php)

Penn State bim resource centre - <http://bim.psu.edu>

Indiana University bim standards - <http://indiana.edu/~uao/iubim.html>

The US General Services Administration 3D-4D bim standard - [www.gsa.gov/portal/content/105075](http://www.gsa.gov/portal/content/105075)

The Port Authority of New York and New Jersey bim standard - [www.panynj-cadstandards.com](http://www.panynj-cadstandards.com)

Denver International Airport bim manual - [http://business.flydenver.com/bizpdf/DIAID\\_907.pdf](http://business.flydenver.com/bizpdf/DIAID_907.pdf)

#### FURTHER READING AND RESOURCES ON SOFTWARE

Autodesk Revit - <http://www.autodesk.co.uk/>

Autodesk user group international forum - <http://forums.augi.com/forumdisplay.php?f=93>

London Revit user group - <http://www.lrug.org.uk/>

Bentley Systems Architecture - <http://www.bentley.com/en-GB/>

Bentley User resource site - <http://www.bentleyuser.org/index.asp>

Gehry Technologies Digital Project Designer - <http://www.gehrytechnologies.com/>

Graphisoft ArchiCAD - <http://www.graphisoft.com/>

Graphisoft user forums - <http://archicad-talk.graphisoft.com/>

Nemetschek Allplan - [http://www.nemetschek.com/en/landing\\_\\_page.html](http://www.nemetschek.com/en/landing__page.html)

Nemetschek Vectorworks - <http://www.vectorworks.net/>

4M BIM Suite - <http://www.bim-architecture.com/>