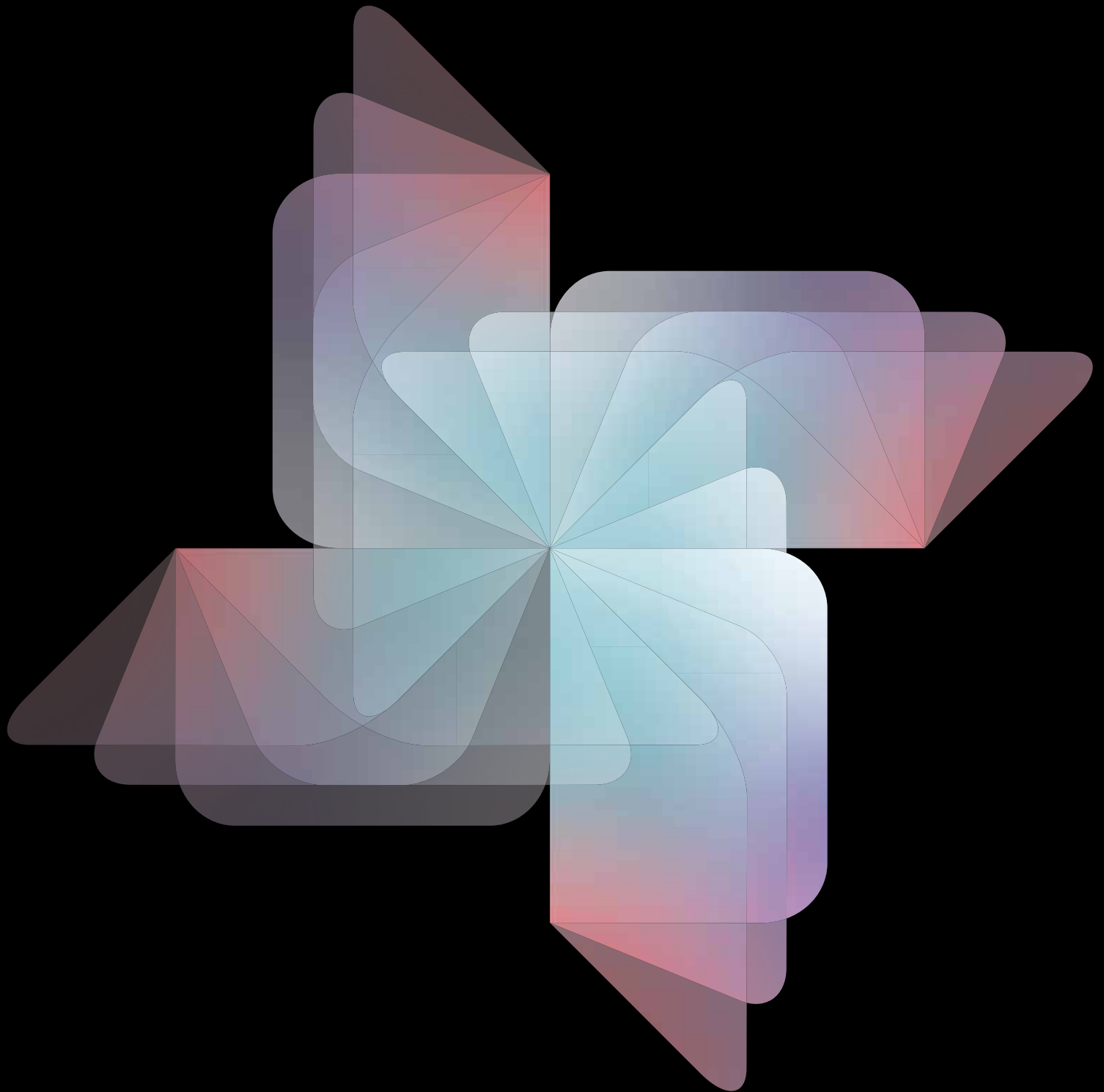


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# National BIM Report 2013



Your free-to-use source of BIM objects.

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We would like to thank the following organisations for supporting this report by circulating the survey to their members:



“We are making great progress and the UK is recognised around the world as leading the agenda for improving efficient and effective construction information.”



## Introduction

### Richard Waterhouse CEO, NBS and RIBA Enterprises

Three years is a long time when considering the impact of new digital technologies. The introduction of BIM is a good example of the kinds of changes that can occur. This third National BIM Survey provides an intriguing insight into the changes that have taken place as well as those that are still required in order to achieve the UK Government’s target of Level 2 BIM by 2016.

The good news is that progress continues to be made in BIM adoption. The 2012 survey shows the percentage of the industry actually using BIM has grown to 39%, up from 13% in 2010. The number of those who have not heard of BIM has reduced from 43% to just 6% in the same period. However, whilst these figures are good to see, a growing percentage of the industry is aware of BIM but is still waiting to take the plunge. Investment costs are still a barrier and concerns remain over the likely returns. Despite the launch of new UK BIM protocols and guidance from the Government, many within the industry also remain confused by the subject and maintain a lack of trust in the claims of what BIM can deliver. This is balanced by the positive comments of those who have delivered projects using BIM and who can demonstrate returns on investment. There is still a real need for training and development that can articulate the reality of BIM, where it needs to go by 2016 and the development of Level 3. Despite this caution, we are making great progress and the UK is recognised around the world as leading the agenda for improving efficient and effective construction information.

Those that have adopted are now testing the reality of BIM. In our first survey, I wrote of ‘putting the I into BIM’ - information at the heart of this developing technology. As we delve deeper into the word of digital construction, we find that the fundamentals of delivering quality information have not changed - don’t expect quality output on poor quality input! The foundation of BIM must surely be the delivery of standardised and consistent information. Without the standardised approach to authoring of both geometrical and non-geometrical objects, any outputs from the model will be inconsistent and will not return valid results for schedules and other information-related queries. This risks delivery of incomplete or inadequate construction information - a needless mistake to make given the variety of freely available generic and manufacturer objects such as those in the NBS National BIM Library and the move to ‘open BIM’ where information is shared.

The team in NBS continues to develop exciting BIM tools that demonstrate how BIM can enable collaboration through the effective use of information, reducing risk as well as saving both time and money. Using plug-ins to link the geometry and specification models is just one of the time-saving tools that are available.

BIM adopters can see that BIM is more than just ‘seductive graphics’ and ‘sexy 3D’. They can demonstrate that effective information management leads to business efficiency and profitability. Clearly the journey is still continuing. BIM is still developing and work on how to deliver to output formats such as COBie still requires completion. However, we look forward to seeing the industry develop to achieve the Government’s goal in 2016. ●

# The UK BIM buzz

David Philp  
Chair, BIM2050 Group;  
Head of BIM, Mace; seconded  
into the Cabinet Office as  
Head of BIM Implementation



“Through communities... we are seeing a cultural shift in sharing and creating networks for the common good.

Our industry is changing rapidly and collectively we are shaping a new future. What will it look like?”



UK BIM has been on the move in the last 12 months, and the ‘what’ and the ‘why’ of BIM have largely been relegated and replaced with the ‘how’. Our BIM revolution is undoubtedly irreversible and is starting to become imbedded in the 21st Century way of digitally creating and maintaining our built environment. However, it is also fair to say that this journey is still in its infancy and whilst many are moving on (relatively unscathed) and upwards from the BIM foothills, we also need to recognise that there is a long tail. We need to support and demystify BIM throughout the entire supply chain, especially the SME and manufacturing community, who are vitally important in the UK’s whole sector approach to BIM. Likewise, we need to ensure that schools and academia alike are providing industry with a new generation who are ‘integrators’, who can deliver better business outcomes in an age of information technology.

We should, as an industry, be especially proud of what has been achieved and indeed many industry commentators are now asserting that the UK has become the world leader in BIM through adoption and the central government policy and the requirements of the Government Construction Strategy. This hypothesis was reinforced by Fiotech, an international community working together to lead global development and adoption of innovative practices and technologies; Fiotech recognized both the HM Government and UK industry for their leadership in advancing technology and improving productivity in capital projects by awarding the James B. Porter, Jr. Award for Technology Leadership. The award also recognises the positive engagement of Government with industry, who are working together well.

Left  
BIMTaskGroup.org

Whilst the enabling technologies and our data sets are a big part of BIM, it has been that level of engagement and open (at times radical) collaboration that has been the big win. Through communities such as the #ukbimcrew (on Twitter), the CIC BIM Regional Hubs and BIM4 working groups such as the BIM4SMEs, we are seeing a cultural shift in sharing and creating networks for the common good.

Our industry is changing rapidly and collectively we are shaping a new future. What will it look like? What changes do we need to make now for a better future? What role will BIM play? These are the challenges that another working group, BIM2050, are tackling. This foresight group made up of 20 young professionals from across 11 different professional institutes is aiming to provide a vision of the future and predict the trends in BIM maturity as we move on from Level 2 BIM, enabling others to shape the opportunity for a fully integrated industry.

With the Level 2 BIM model and deliverables from the BIM Task Group now complete and anchored, and with the publication of PAS1192:2 and the BIM protocol, many are asking where the next turnpike will take us.

A recent HM Government report highlighted the need to ‘help create the future by continually developing our capabilities’ in BIM. With the BIM Task Group releasing the ‘Labs’ space on the [www.bimtaskgroup.org](http://www.bimtaskgroup.org) website, a ‘beta’ version which is published with the intention of eliciting feedback to assist in final testing before official (production) release, we can start to see what could be next and what a ‘digital Plan of Work’ could help achieve in a world of digitally enabled transactions.

We will also likely go full circle this year and return to the ‘what’ and the ‘why’ questions in relation to Level 3 BIM and what needs to be done to help ensure we stay at the vanguard of UK BIM maturity. Ultimately, the best way to predict an integrated BIM future is to create it! ●

# The UK BIM Buzz part two: views from those making UK BIM a reality

Those at the forefront of BIM offer their views on BIM in the UK, and the importance of the survey's findings

## Stefan Mordue

Technical Author, NBS;  
Communications Manager,  
BIM 2050 Group

By 2050 construction roles will be unrecognisable from the roles of today. While it is exciting to look at future technologies, it is also important that we understand how developments such as BIM will be influenced by other mega-trends, such as demographics and urbanization. By looking at these and also learning from other industries outside of construction, we can begin to gain an understanding of how we will be using data in the future and how best we can leverage the benefits. No one truly knows what the future holds. We can take a good informed guess based upon trends, but the best way to predict an integrated BIM future is simple. We need to create it.



## Nick Nisbet

Owner,  
AEC3

This is the most exciting NBS report yet: sometime this year, isolated (little) BIM will probably become the norm in practice. Meanwhile, the ideas around collaborative (big) BIM have taken root. Now there is a real thirst for knowledge of how to plan not only for greater efficiency, but also for better checking and improved collaborative processes. Both buildingSMART, through its User group, and the UK Government BIM Task Group, through its BIM4 groups, look forward to reaching further out to the wider community.



“It will be the cultural and behavioural changes that many will find most difficult, and yet I believe these will prove to be the most important if we are to be successful.” Nigel Clark

## Nigel Clark

Technical Director,  
Hilson Moran

Successfully implementing BIM represents the biggest change the construction industry will see for many years. For the Building Services Engineer the challenges will be considerable because of the multitude of systems and services they have to deal with. There will be investment and training required and technical challenges to overcome, but it will be the cultural and behavioural changes that many will find most difficult, and yet I believe these will prove to be the most important if we are to be successful. Engineers of the future will be different to those of the past and will work in new ways to extract the most out of this exciting opportunity.

I'm looking forward to it.



## Rebecca De Cicco

Technical Associate and BIM Specialist,  
KSS Group

Adoption of BIM in the UK has been incredibly positive in the last year. Practices are engaging on all levels to understand its relevance in today's ever changing construction landscape. The widespread adoption has seen a positive change in the way we communicate and collaborate, and in turn how this sharing culture enables a more informed and aligned process in building construction all over the world. The future is uncertain but we can ascertain that with this driven approach, associated groups and changed roles and our passion to succeed, this process will only become more relevant leading up to 2016 and beyond.



Alistair Kell

Director of Information and Technology,  
BDP

The key findings of the National BIM Report are no surprise and reflect BDP's recent experience. It is clear that over the last three years there has been significantly more uptake within the UK but neither knowledge nor usage are at a uniform level across all areas of building design, delivery and operation as yet.

With clients and contractors increasingly demanding BIM deliverables the UK's position will continue to strengthen as the processes and workflows mature to ultimately be seen as the norm. We need to 'keep the faith' and best harness the benefits BIM can bring overall!



**BDP.**

Casey Rutland

Associate Director,  
Arup Associates

It's that time of year again where industry reflects on the state of the UK's BIM 'maturity' and this year's key findings are encouraging. Whilst not the most significant jump in uptake, we now have three quarters of those surveyed now in agreement that BIM is the future of project information and that it will promote cross-discipline co-operation, proving perhaps that if BIM didn't 'work' it would have been discarded long ago.

There's still some way to go in educating the majority, but with people passionate about changing the whole industry leading the charge, we can expect to see significant, tangible demonstrations of the 'benefits of BIM' very soon.



**ARUP ASSOCIATES**

Kevin Lloyd

Principal BIM Integrator,  
Balfour Beatty

The growth in BIM adoption in the UK construction industry is really encouraging considering the tough economic conditions. What is even more encouraging is that businesses who are utilising BIM are beginning to think more about the management and value of the data across the whole asset lifecycle, but there is still a long way to go in realising the true benefits.

The cultural rewiring of the industry in moving to a more collaborative and transparent platform is still the greatest challenge. The industry as whole must do more in encouraging those, and in particular the supply chain, who have not made the leap yet.

BIM is now perceived as a force for good. Confidence will come with experience, but it's about getting involved in the first place.



**Balfour Beatty**

Rebecca Hodgson-Jones

Head of BIM,  
Sir Robert McAlpine

We are at war with our economy and this is delivering innovation. This is providing the industry an opportunity to re-focus on long standing issues but, with one fundamental difference: the change required can be enabled by adoption of new technologies. The continued growth in the uptake of BIM, indicated by the 2013 National BIM Survey, gets us closer to the tipping point, providing a 'perfect storm' to drive out the waste that exists within our industry. However, there are still barriers to change and, from the survey results, it is clear that significant work still has to be undertaken. For most the question of 'should' is now history and it's about how we, as built environment professionals, can maximise value and efficiently deliver sustainable whole life solutions.



**Sir Robert McALPINE**

"We can take a good informed guess based upon trends, but the best way to predict an integrated BIM future is simple. We need to create it."

Stefan Mordue

Bill Gibson

Head of Marketing Communications,  
Kingspan Insulation

Kingspan Insulation welcome the publication of the 2013 National BIM Report. We used previous reports to help formulate our own BIM strategy on the basis that NBS holds clear and credible information on the state of BIM adoption and usage in the UK.

Our commitment to ensuring we are at the forefront of the provision of manufacturers' data is borne out in this year's findings, as adoption continues apace across the industry.



**Kingspan Insulation**

### John Tebbit

Industry Affairs Director,  
Construction Products Association

There is a wide range of readiness within the manufacturing sector for BIM. For some they have been involved for years whereas others have yet to recognise the challenges and opportunities. A key issue for the sector is confidence that Government will stick to its guns on open, non-proprietary standards. Early signs are encouraging but there are still threats from major software companies and also some Tier 1 contractors who would prefer to lock supply chains into their own proprietary systems. This would increase costs for suppliers and hence reduce the speed of uptake which is not what we want.



“Whilst not the most significant jump in uptake, we now have three quarters of those surveyed now in agreement that BIM is the future of project information and that it will promote cross-discipline co-operation, proving perhaps that if BIM didn’t ‘work’ it would have been discarded long ago.” Casey Rutland

### Simon Rawlinson

Head of Strategic Research and  
Insight, EC Harris; Chair of Research,  
British Council for Offices

We have seen a real acceleration of interest from private sector clients in the past year – triggered no doubt by the profile that BIM secured as a result of the launch of the Government BIM Strategy. Commercial clients are being selective in their use of BIM – focused on areas where they see greatest value. Interestingly this includes the operation and maintenance of buildings as well as the coordination of the design and optimisation of construction. The direction of travel indicated by the survey is encouraging – awareness has increased, but most people recognise that they have to develop their skills and expertise.

I expect to see greater rigour in the application of BIM to projects in 2013 – as protocols and other commercial documents become established, and as learning is captured from early projects.



### David Light

Director of Implementation,  
CASE Inc

In the UK, the adoption of BIM is progressing well with much of this to do with the Government’s 2016 requirements. Nevertheless we are still really at the beginning of this journey; we have a long way to go before BIM truly hits the mainstream. The challenge remains that there are so many aspects which make up the BIM process, that many firms are struggling to work out what areas of BIM they should or shouldn’t be focusing on and then aligning that with an appropriate educational program. For BIM to work it needs to be integrated into a business’s strategy with clear defined and realistic goals. Setting expectations with the correct training is crucial for any technology implementation to succeed.



“The widespread adoption has seen a positive change in the way we communicate and collaborate, and in turn how this sharing culture enables a more informed and aligned process in building construction all over the world.”

Rebecca De Cicco

### Darryl Store

Associate (BIM),  
PRP Architects LLP

The fact that nearly 40% of practices are reporting the use of BIM is encouraging. However, using a BIM platform is not necessarily the same as being involved in the BIM process.

Only half the industry being aware of the different BIM maturity levels indicates that there is still much work to be done educating the entire industry. It’s an exciting time to be involved.



# BIM Survey: Summary of findings

Adrian Malleson  
Research and Analysis  
Manager, NBS



“We’re pleased to say that we’ve had the largest number of survey responses yet... This level of response reflects the importance of BIM to the industry. It also shows the need for dispassionate reporting of what’s really going on. We aim to provide that.”

## Introduction

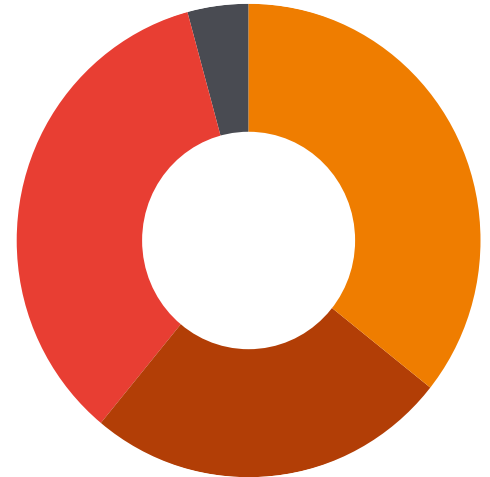
Following our 2011<sup>1</sup> and 2012<sup>2</sup> reports, here is our third set of research findings into BIM and the UK construction industry. We carried out the research in late 2012 and early 2013. We’re pleased to say that we’ve had the largest number of survey responses yet; this year we’ve had over 1,350 responses compared to around 1,000 in 2011 and 500 in 2010. This level of response reflects the importance of BIM to the industry. It also shows the need for dispassionate reporting of what’s really going on. We aim to provide that.

As ever, we’re very grateful to those of you who took the time to complete the survey – without the responses there could, of course, be no report. The free text responses are fascinating and they are used in this report to illustrate some of the main findings.

We’re also grateful to the many professional bodies that publicised the survey to their membership. This kind of assistance is vital to providing a rounded set of findings where all professions have a chance to put forward their view – particularly as collaboration is at the heart of BIM.

Whilst architects remain the largest group of respondents – they make up over a third – there are significant other groups, including architectural technologists, (14.4%), building services engineers (4.9%), building surveyors (4.5%) and landscape architects (3.3%). We also received responses from, among others, chartered surveyors, building engineers, civil engineers, facilities managers, structural engineers and contractors. This year’s responses are from a more diverse range of professionals than previously.

During the three years we have been running this survey we have kept a core of questions that we have asked each year. This allows us to track changes and trends in the industry. Once again, though, we need to be careful. Because more and different people respond to the survey now, comparisons we make with previous surveys are best read as indicative rather than definitive. Nevertheless, some very clear trends emerge from the UK’s largest BIM survey. So let’s look at them.



Use of CAD: comparison

No CAD	36%
2D only	25%
2D and 3D CAD	35%
3D only	4%

## CAD usage

Three years ago, when we started to explore attitudes to BIM, we wanted to understand use of the technology that many see as a precondition for it – 3D CAD. Indeed, we were concerned that people thought that BIM is 3D CAD. Well, we’ve established that the industry does not think ‘BIM is just a synonym for 3D CAD drawings’ – only 15% of respondents now agree with that statement. A majority see that BIM is not ‘just about software’ (less than a third agree that it is). BIM is not just geometric data.

Indeed, there is some suggestion that concentrating on just producing excellent 3D CAD models can hide poor construction information.

“All CAD drawings look great even if the content is nonsense”

Nevertheless, the capabilities of CAD software – along with software independent formats and standards for information exchange – are a vital part of the BIM toolbox.

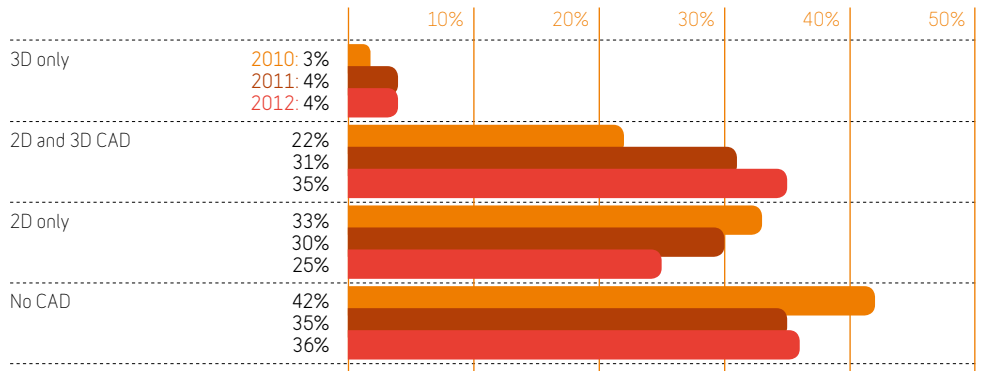
“BIM is an inevitable development from 3D CAD”

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1. [thenbs.com/pdfs/bimResearchReport\\_2011-03.pdf](http://thenbs.com/pdfs/bimResearchReport_2011-03.pdf)
2. [thenbs.com/pdfs/NBS-NationalBIMReport12.pdf](http://thenbs.com/pdfs/NBS-NationalBIMReport12.pdf)



CAD drawing: types done

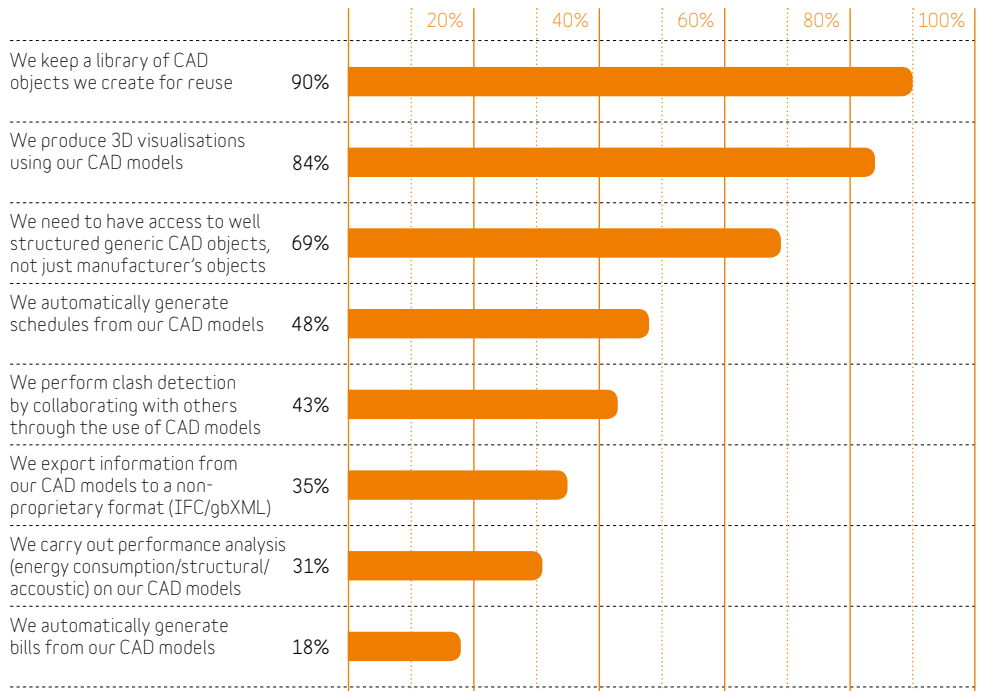


This year we have seen an increase in the numbers using 3D CAD - now nearly 40%, up from just over a third in 2011. This has come from a decrease in the number using only 2D CAD, and a corresponding increase in those using both 2D and 3D CAD. The numbers using only 3D CAD, and those not using CAD at all, have remained about the same, however.

Respondents are continuing to use their CAD models for a range of purposes. Ninety per cent keep a library of CAD objects for later re-use, 84% produce 3D visualisations, 43% carry out clash detection. However, less than a third carry out performance analysis.

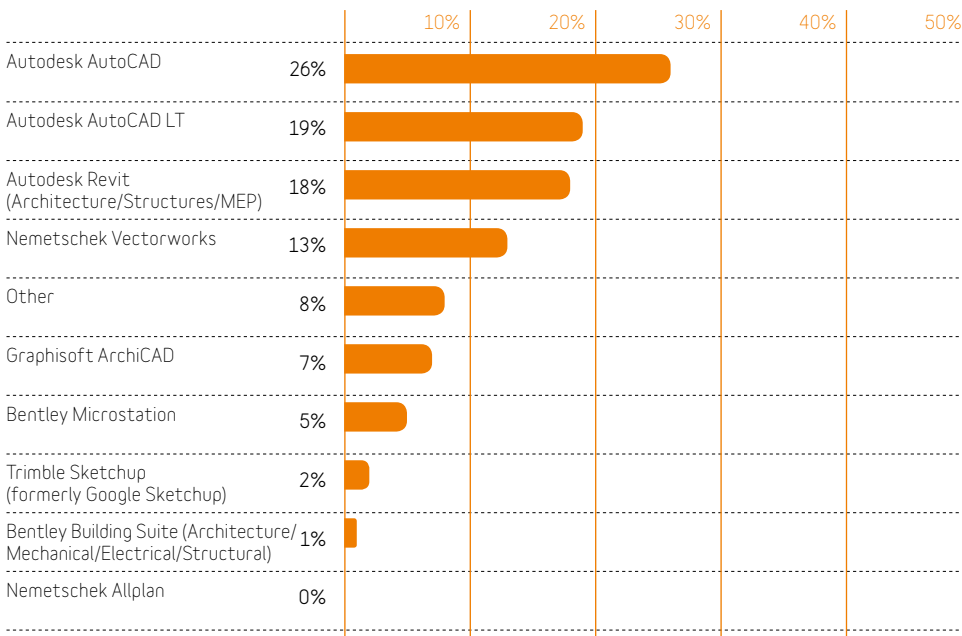
Around a third of people, 35%, tell us they export information to a non-proprietary format - central to higher levels of BIM where information is shared, irrespective of software used. We'll look at this in more detail later.

Where do you get the CAD objects your organisation uses?



“Three years ago, when we started to explore attitudes to BIM, we wanted to understand use of the technology that many see as a precondition for it - 3D CAD. Indeed, we were concerned that people thought that BIM is 3D CAD. The industry does not think ‘BIM is just a synonym for 3D CAD drawings’.”

When producing CAD drawings, which of the following tools do you mainly use?



We also asked which CAD package CAD users mainly use. We found that Autodesk, in its various flavours, accounted for around two thirds of the 'mainly used' packages, but there are significant other players in the market, notably Nemetschek, Graphisoft and Bentley.

Once again, whilst there is an appreciation that BIM is not 3D CAD, and 3D CAD is not BIM, purchasing, deploying and using 3D CAD is seen as a precondition for BIM.

*"We are starting out by training staff to use 3D software"*

*"Making the shift from a traditional 2D workflow to a 3D BIM workflow is a big culture shift"*

*"We will take the BIM plunge, by getting our first seat of Revit and interfacing with NBS Create"*

Whilst adoption of 3D CAD is increasing, when we looked at the free-text comments about CAD, we found a distinct unease among some,

a feeling that perhaps the move to 3D CAD (and BIM) is driven by the commercial interest of software houses, rather than by a need to improve the construction process.

*"The CAD companies are embracing the Government view with open arms, as it will massively boost their sales. There is a horrible smell of self interest/financial incentive here!"*

*"BIM is just another opportunity to fleece us again"*

*"It does feel like another huddle to keep the small practices out of the loop"*

Later, when we look at people's attitudes to BIM, we'll see that this is a minority view and that most clearly see the benefits of BIM. But it is a view that is deeply held by some, particularly among smaller architectural practices. When thinking about the processes and tools that we, as an industry, are developing to support BIM we can't ignore this view if we want to be inclusive.

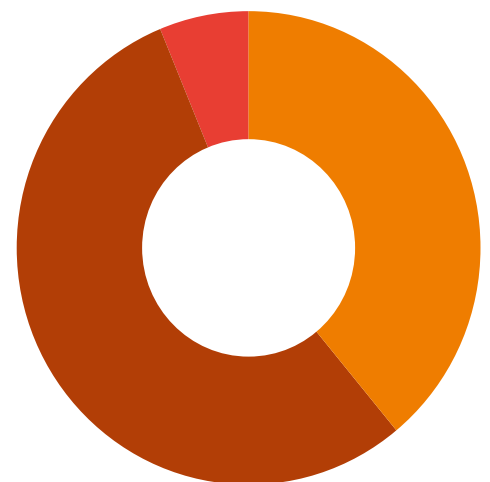
### BIM usage and awareness

Strikingly, in this year's survey, only 6% had not heard of BIM. This may well reflect the amount of interest and publicity there is for BIM now as 85% agree 'you hear more and more about BIM these days'. But this isn't just talk. BIM adoption is also up, though less dramatically in 2011 to 2012 than from 2010 to 2011.

In 2010, we asked whether people had heard of BIM and whether, in three years' time, those who had heard of it would be using it. At the time, 43% were neither aware of nor using BIM.

Of those who were aware of BIM, just over 80% predicted that in the next three years they would be using BIM and 62% that they would be using it in one year's time. Well, forecasts are always dangerous things. Let's see how the BIM prediction has panned out.

We've gone from only 13% being both aware of and using BIM in 2010 to 39% in 2012. If we allow for adoption primarily by those who were aware of it three years ago, this is broadly in line with predictions. This is a dramatic adoption of new technology and working practice. We can reasonably expect further increases in BIM adoption as the Government's Construction Strategy becomes reality and as the construction industry inches out of recession.



Awareness and use of BIM

Aware and currently using BIM	39%
Just aware of BIM	54%
Neither aware nor using	6%

This view is supported by predictions about future adoption. We asked those who are aware of BIM (which now, unlike in 2010, is almost everyone) whether they will adopt BIM in the coming years. More people think they will; momentum continues to grow.

*"I am looking forward to the next couple of years and how the industry is going to look as a BIM proficient industry"*

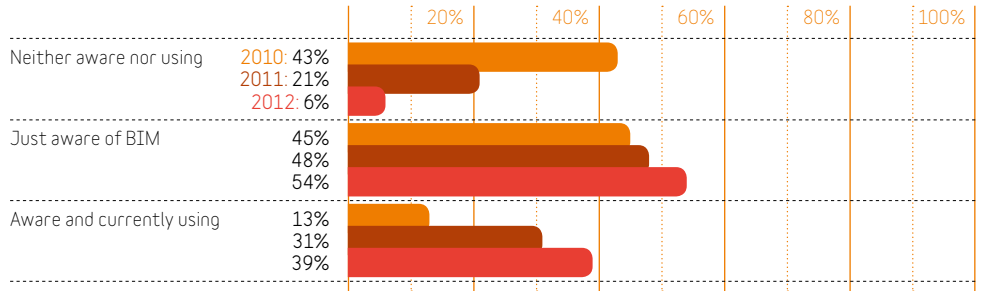
That said, we found that people from larger organisations were more likely to agree that 'BIM is the future of project information'; over 80% of those from companies with more than 250 employees agreed, compared with 62% of those from practices with one or two people.

*"The investment in software and training for implementing BIM is much easier for large organisations particularly in the current tough economic times"*

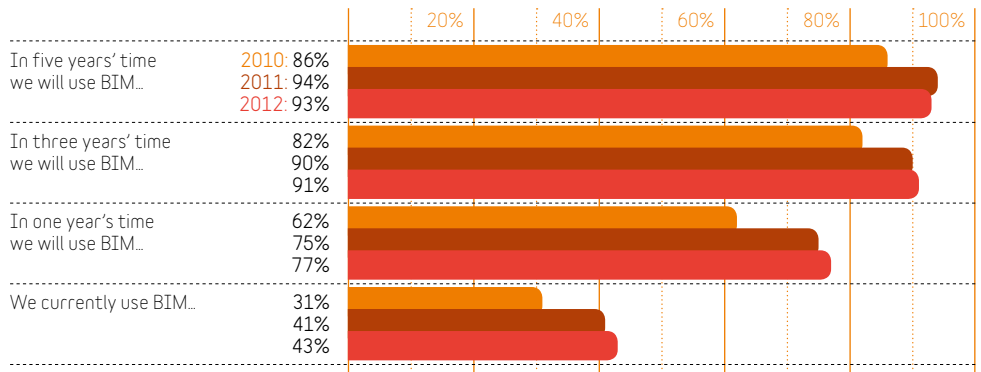
If BIM is to be the new standard for project information, it must accommodate all practice sizes.

*"Slightly worryingly though, almost three quarters still feel that the industry is not clear enough on what BIM is; this number has remained about the same as last year"*

**Awareness and use of BIM: comparison**



**Projected use of BIM among those aware of it**



**Attitudes towards BIM**

We wanted to find out what people felt about BIM, and their attitudes towards it. You can see the main findings in the graph, but it's worth picking out a few points. People are rightly clear that the Government will start insisting on BIM for public sector work (80% agree) and the majority (51%) agree that the Government is on the right track with BIM. There is clarity on what BIM isn't. It isn't '3D CAD drawings', it's not 'all about software'. BIM doesn't 'lead to bland buildings', it isn't 'just for new build' and it doesn't stand in the way of 'bespoke design'.

Slightly worryingly though, almost three quarters still feel that the industry is not clear

enough on what BIM is; this number has remained about the same as last year and this has gone up by 10% from when we first asked.

*"BIM seems to be very obscure and few of my colleagues or appointees in all the consultant fields seem to have any understanding of it"*

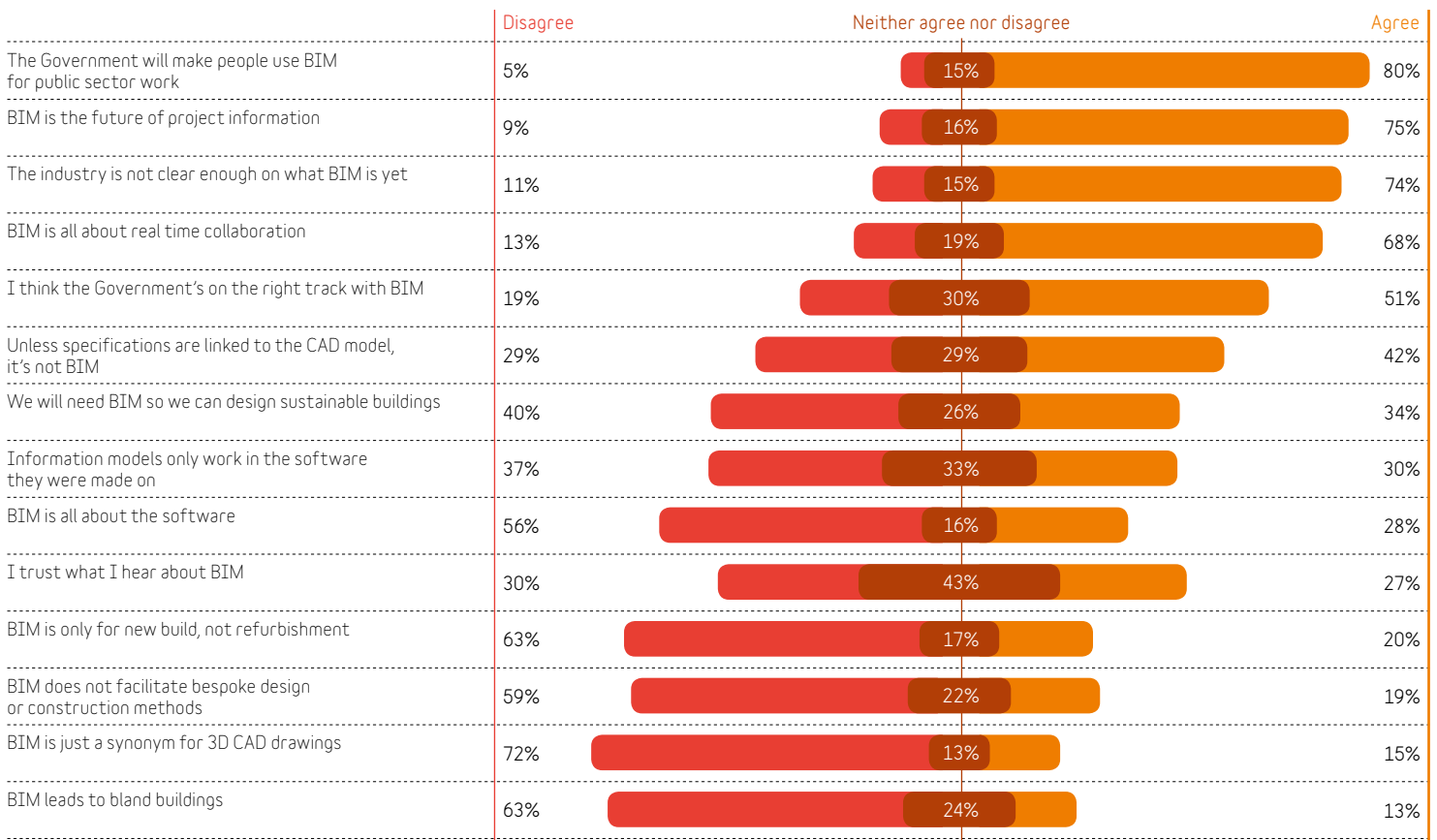
This may be related to a growing scepticism about available information. Only around a quarter of people (27%) agree that 'I trust what I hear about BIM'. Further, when we asked about how confident they are in their knowledge and skills in BIM, more people told us they were 'not confident' than 'confident'.

There's still work to be done.

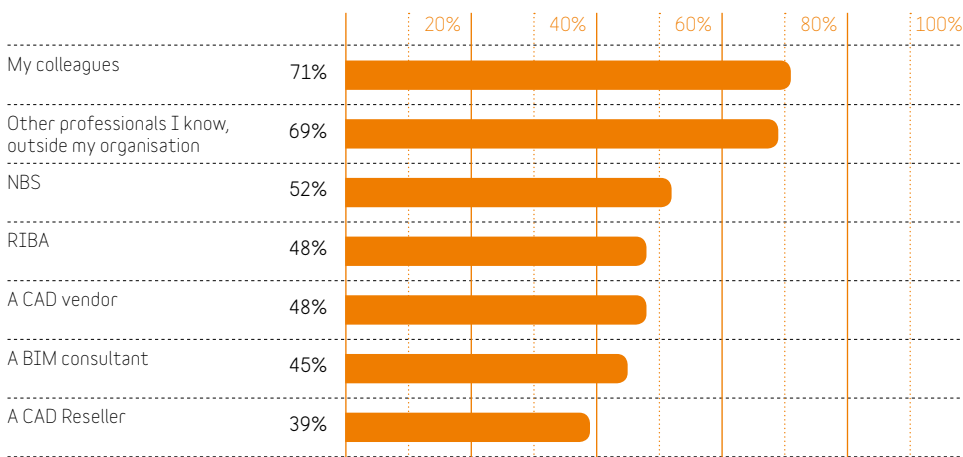
**How confident are you in your knowledge and skills in BIM?**



From your understanding of BIM, how strongly do you agree or disagree with the following statements?



Are you likely to turn to the following sources of information about BIM?



"It is clear that we will have to grow our knowledge of/use of BIM over the next year"

"More awareness presentations, publicity and training required"

"We have virtually no knowledge of what BIM entails or means to us operationally"

That said, there are available sources of BIM information that people told us they will turn to. Most people are likely to turn to fellow professionals, whether colleagues (91%) or other professionals (69%) in other organisations. NBS (52%) and the RIBA (48%) are also valued resources.

**BIM and Government policy**

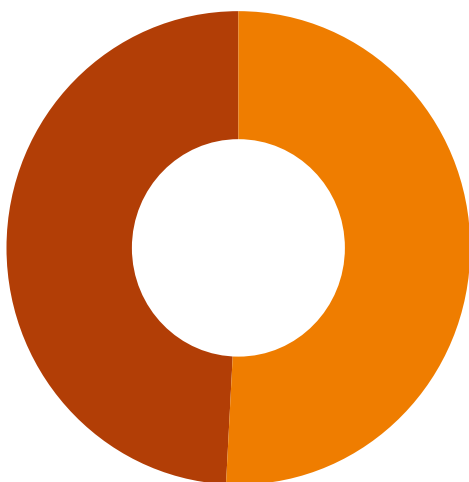
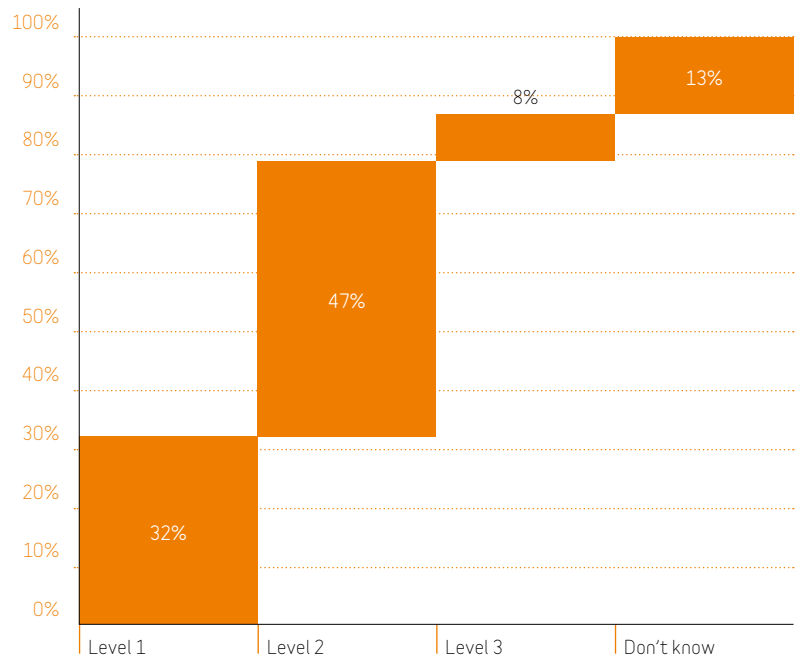
Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016. Government Construction Strategy, May 2011<sup>3</sup>

“[Our organisation is] completely unaware that we will be required by Government to be at BIM Level 2 in three years’ time. There seems to be no clear information available on this”

The Government set out its goal for BIM in its construction strategy. We’ve seen that in this regard, most people feel the Government is on the right track. Integral to this strategy is the movement from no BIM, to Level 1 then to Level 2 BIM<sup>4</sup>. We found that, of those aware of BIM, around a half were aware of these gradations of BIM maturity, around a half not.

Among those who were aware of the different levels, only 8% have reached Level 3, though almost a half tell us they have reached Level 2, the level the Government’s construction strategy calls for by 2016.

What level would you say is the highest level your organisation has reached on a project?



The Government has described three levels of BIM. Are you aware of them?

Yes	51%	●
No	49%	●

“The Government set out its goal for BIM in its construction strategy. We’ve seen that in this regard, most people feel the Government is on the right track..

Among those who were aware of the different levels, only 8% have reached Level 3”

References

- 3. [gov.uk/government/publications/government-construction-strategy](http://gov.uk/government/publications/government-construction-strategy)
- 4. [bimtaskgroup.org/wp-content/uploads/2012/03/BIS-BIM-strategy-Report.pdf](http://bimtaskgroup.org/wp-content/uploads/2012/03/BIS-BIM-strategy-Report.pdf)

In the move towards the higher levels of BIM, to BIM being fully collaborative, there's a need to adopt open, sharable, non vendor specific data formats, typically IFCs (Industry Foundation Classes).

There's also a need for data, via COBie (Construction Operations Building Information Exchange) drops, to inform ongoing building maintenance. We asked about both of these.

*"Although as a company, we have adopted BIM and are slowly understanding IFC and COBie, there is still a long way to go"*

We found that whilst 39% use IFC, 31% don't, and a further 30% don't know whether they do or not - strongly suggesting the industry needs more available information and education here.

*"The development of IFC is paramount to true collaboration"*

*"We believe we are making good progress with BIM beyond just 3D modelling and use IFC to successfully collaborate with the Structural Engineer"*

*"...the economy and the lack of funds to invest remain a real barrier to BIM adoption. The ongoing contraction of the construction industry may help explain why adoption has not been as high as predicted in our 2011 report."*

A smaller number, 15%, produce COBie output, a majority, 56%, don't, but again the number of people who 'don't know' is high at 28%. Given the greater efficiencies BIM can deliver to building operation, and so to our clients, we hope the numbers generating COBie output increases in the coming years.

**BIM experience**

Forty-seven per cent of those who have yet to adopt BIM agree that 'we need to get through the downturn, then we'll look at BIM' - the economy and the lack of funds to invest remain a real barrier to BIM adoption. The ongoing contraction of the construction industry may help explain why adoption, though high, has not been as high as might have been.

*"Cost is the most significant barrier to adopting BIM."*

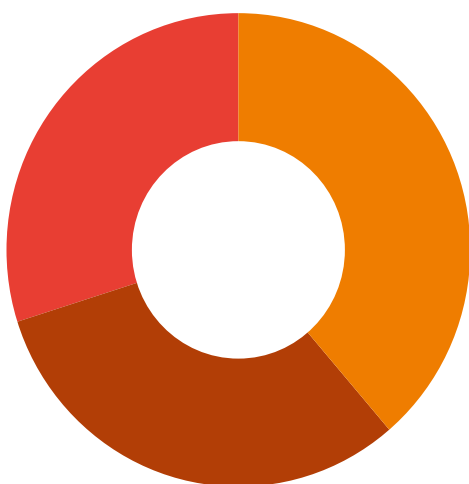
But the results of the survey suggest the adoption process is (for all the scepticism we saw earlier) a worthwhile one.

*"BIM, in my opinion, is going to become a driving force in future construction"*

We again looked at the views of those who have adopted BIM and compared it with those who were aware of BIM, but who had not yet adopted its use. This allows us to compare expectation with experience. It is common for new business processes and associated software to look better in anticipation than reality. But that is not so with BIM, it's the reverse. In every measure, those who have adopted BIM are warmer to it than those who have yet to.

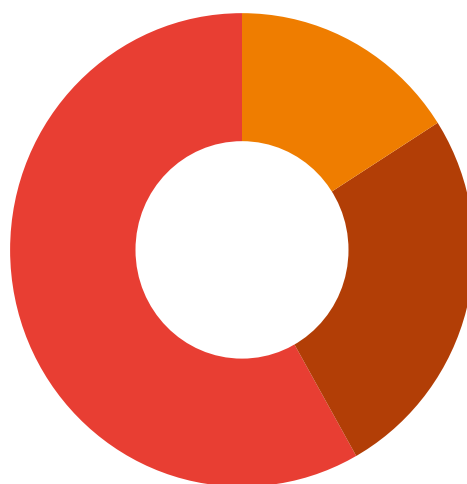
*"Ultimately, its success depends on whether it saves time, ultimately leading to profit for company and cost cutting for clients"*

For example, whilst only a third of non-users think that BIM would improve document co-ordination, three quarters found that it did. Only 6% wished that they hadn't adopted BIM, whilst 22% of non-users would rather not adopt BIM. More importantly perhaps, 55% of users found that BIM brought cost efficiencies, 50% that it increases the speed of delivery and 46% agreed that it increased profitability (21% disagreed, the remainder, a third, were neutral). At a time where project profitability has become more challenging than ever, these results suggest BIM may offer a means to more work, and work that's more profitable. At the very least, if clients, Government and contractors increasingly demand it, not adopting BIM may be a competitive disadvantage.



Do you use IFC on your projects?

Yes	39%
No	31%
Don't know	30%



Do you generate COBie output on your projects?

Yes	16%
No	56%
Don't know	28%

**End note**

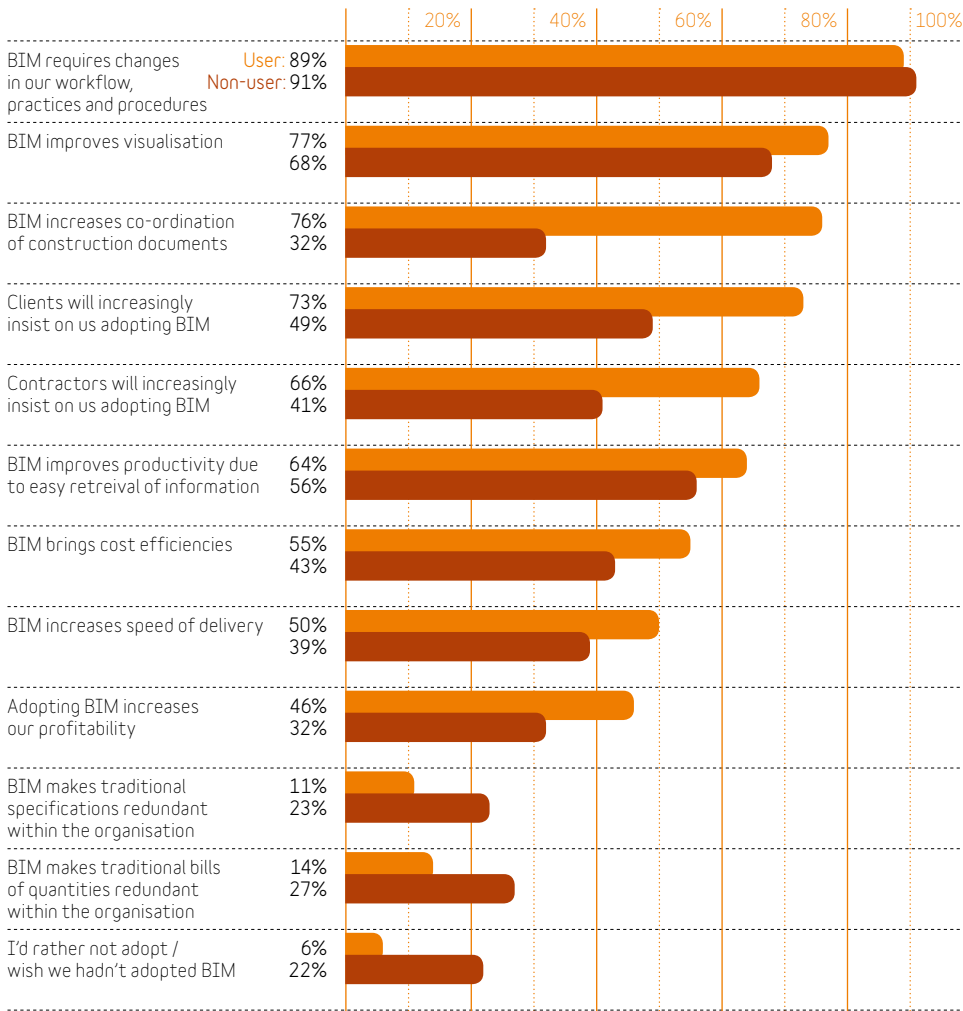
As we saw last year, the use and awareness of BIM is increasing. However, the ongoing recession in the construction sector serves to hold back adoption. Some smaller practices, in particular, have reservations about BIM, software vendors and the Government strategy. There is still a lack of clarity about open file formats and how the information at the heart of BIM can be openly shared, independent of particular software.

But overall, the industry is positive about BIM. A majority think the Government is on the ‘right track’ with BIM. Those who are looking to BIM see its advantages, but tend to understate them. Those who have adopted BIM tell us that there are real benefits to be

had, and they’re greater than expectations. The anticipation of future adoption remains high. Delaying BIM implementation may reduce expenditure – but the risk is an even greater reduction in future income. ●

“Those who have adopted BIM tell us that there are real benefits to be had, and they’re greater than expectations. The anticipation of future adoption remains high.”

**Attitudes towards BIM:**  
A comparison of those who use it, and those who don’t



# The RIBA Plan of Work 2013 and BIM

Dale Sinclair  
 Director, Dyer;  
 Chair, RIBA Large  
 Practice Group



The RIBA Plan of Work 2013 has been conceived for use on the most progressive of BIM projects. It has been developed to achieve this goal along with a number of supporting publications that help to facilitate the tasks that are embedded in the Plan.

One of the most important tasks on any BIM project is properly assembling the project team. The shift in emphasis from the design team (as set out in the 1963 RIBA Plan of Work) to the project team is in itself a core message to be derived from the RIBA Plan of Work 2013. In assembling the project team the new Plan of Work advocates the consideration of who does what, when and how. These simple concepts and their relevance to BIM can be summarised as follows:

## Who

Project teams are becoming more and more complex. BIM allows us to start designing in a quicker and more detailed manner. This requires a greater degree of clarity earlier on in the process to ensure that each member of the project team understands their role, to ensure that fees have been allocated appropriately, and more importantly to ensure that there are no gaps in the services that need to be provided. The RIBA Plan of Work 2013 sets out the notion of a Project Roles Table and the connected (but different) need for a Contractual Tree in order to allow discussion around the development of the collaborative project team and to capture this information at a high level before detailed schedules of services and other contractual documents are prepared.

“Collaborative contracts have promoted the importance of programmes in professional services or building contracts for some time. The RIBA Plan of Work 2013 takes this notion further... It is only by having detailed programme discussions that project risks can be understood and shared appropriately.”

The image shows a page from the RIBA Plan of Work 2013. At the top, it says 'RIBA Plan of Work 2013'. Below that is a table with 8 columns representing stages (0 to 7) and several rows representing different project phases. The columns are: 0 (Project Initiation), 1 (Project Brief), 2 (Concept Design), 3 (Develop Design), 4 (Technical Design), 5 (Manufacture Design), 6 (Construction), and 7 (Use). The rows include: Use Definition, Programme, Client Planning, and Bid Support Tools. The table contains detailed descriptions of tasks and responsibilities for each stage and phase.

Left  
 RIBA Plan of Work 2013



### What

The Plan of Work 2013 encourages the preparation of documents that ensure that each party is aware of what they have to do. Three tools are proposed:

#### Schedules of Services

These will place greater emphasis on, and be aligned with, the tasks set out in the RIBA Plan of Work 2013. They will not set out tasks in relation to a professional's day-to-day tasks; it will be the responsibility of each designer to use their skills to achieve the briefed requirements and the stated level of detail in the information exchanges. The Schedules will also address duties required as part of the Handover Strategy (derived from the BSRIA Soft Landing initiative) pre- and post-handover, as well as new duties that may be required in relation to asset management and other new subjects. The schedules will also consider project outcomes, the need to state them in the project brief and then any requirements to assess them post-occupancy.

#### Information Exchanges

Many projects still work on the notion that full size models need to be printed to a 'scale'. This 'analogue' way of thinking is slowly being replaced by the 'digital' notion that a BIM model should be produced to a certain level of definition. This level will be dependent on design responsibility issues and on the purpose of the information. For example, client sign-off, specialist contractor design development, planning, etc. More information on this subject will be published in 2013. The RIBA Plan of Work 2013 has been developed to accommodate these discussions without impacting on the Plan of Work itself.

#### Design Responsibility Matrix

JCT contracts have addressed the need to contractually agree the extent of design work undertaken by specialist contractors (Performance Specified Work) for a number of years. The RIBA Plan of Work 2013 suggests the preparation of a Design Responsibility Matrix so that it is clear at the outset to all parties in the project team which aspects of the design will be designed by specialist contractors and which aspects will be constructed on site from information prepared by the design team.

### When

Collaborative contracts have promoted the importance of programmes in professional services or building contracts for some time. The RIBA Plan of Work 2013 takes this notion further and encourages the preparation of a Project Programme that is agreed by all members of the project team. The Project Programme would dovetail with any Design Programmes co-ordinated by the lead designer and with the contractor's Construction Programme. It is only by having detailed programme discussions that project risks can be understood and shared appropriately.

### How

Very few standardised processes emerged from the growth of CAD. Whilst the likes of CPIC have tried to bring some clarity to this subject, and we are close to the publication of PAS1192, it is fair to say that most practices utilise their own CAD Manual which they believe to be the best and most appropriate way of working! These CAD Manuals are developing into BIM Manuals.

However, BIM requires close working protocols for all members of the project team to ensure that information can be properly shared and used by each party. For those working with different consultants, it can be frustrating to have to work to different protocols on different projects. The Plan of Work 2013 advocates the preparation of a Project Execution Plan that sets out the structure and information for each party and individual in the team as well as communication and technology (including software and hardware) strategies and information on any specific BIM aspects such as file-naming protocols. The title ensures that all subjects, not just BIM, are considered holistically and not individually. Of course, the RIBA cannot be prescriptive in terms of outlining requirements but nudges can be made to try and encourage all parties to use common protocols and processes with a view to achieving a "plug and play" environment where each designer can move seamlessly from one project to the next.

### Conclusion

BIM as a term is being used as a wrapper for many subjects. The RIBA Plan of Work 2013 sows the seeds to encourage many subjects to be considered. It acts as a stepping stone as the construction industry harnesses BIM in order to be more efficient and effective. Further information on the subjects above and the many other ideas tackled by the RIBA Plan of Work 2013 will be available when the new Plan is launched in May. ●

Project Team  
=  
Client  
+  
Design Team  
+  
Contractor

#### Further reading

Guide to Using the  
RIBA Plan of Work 2013  
Buy online at RIBA Bookshops:  
[ribabookshops.com/plan-of-work](http://ribabookshops.com/plan-of-work)

The RIBA Job Book (9th edition)  
Buy online at RIBA Bookshops:  
[ribabookshops.com/plan-of-work](http://ribabookshops.com/plan-of-work)

# Looking into the digital crystal ball

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Dr Stephen Hamil  
Director of Design  
and Innovation,  
and Head of BIM,  
NBS



“In the UK, the foundations for a digital construction future are now being put in place... In addition, the move to the cloud is changing the way teams collaborate through data access and data sharing. With this in place, what will the construction industry look like in 2020?”

Advances in digital technology, the move to a low-carbon economy and the global marketplace are changing the way that we design, construct and operate buildings. All companies involved in the industry are asking what this means to them in terms of their business processes.

In the previous seven or eight years technology has had a huge impact on our social, cultural and business lives. This digital revolution will have a similar impact on the construction industry.

In the UK, the foundations for a digital construction future are now being put in place. These foundations include consistency in classification, standardised information requirements and guidance to help make the correct decisions quickly. In addition, the move to the cloud is changing the way teams collaborate through data access and data sharing. With this in place, what will the construction industry look like in 2020?

## Building design

Information will be available, in the correct format, and when it is needed.

When selecting a product, designers have always specified in terms of its performance or its product reference. Manufacturers are aware of this and they will provide this information online, in a standardised digital structure that is immediately accessible. This will allow more informed decisions to be made based on structured criteria such as performance, financial cost, environmental

impact cost, durability, third party certification and warranty. Being able to compare products on a 'like-for-like' basis will mean that decisions are made based on the quality of the product and not on the quality of the marketing spend.

Where products need to be assembled to form a system, the user will be able to do this online through a user-friendly interface. Manufacturer products will be configured to suit, then an object will be generated that meets the project need. This will greatly reduce and perhaps eliminate the chances of specifying incompatible products in a system.

A library of information from hundreds of manufacturers and with hundreds of thousands of products will be on the cloud, and by normalising the information available in the market place, specification values will be suggested to designers. The correct information will be delivered to the design team when they require it and it will be delivered instantly.

Automation during design is already helping enormously: for example, automatically linking specification references and drawings where at one time this was done with tracing paper and pencil. This automation will continue with computer power doing tasks that were previously tedious, such as checking designs against regulations or requirements. Looking at current Approved Document guidance on how to achieve Building Regulation approval, smoke detectors must be positioned in certain locations. Through correct classification

of objects and spaces, this is a manual task that will be automated. When considering the analysis of the performance of the design (for example spread of flame, accessibility, thermal performance) - this will also be automated and the result of this will be instantly conveyed to the user. Not all checking will initially be possible by computer, but digital information will be automatically collated so that expert compliance checking can then be done in a fraction of the time. In some cases, where standardised details and components with third party certification are used then parts of the regulations will automatically pass.

Designers are used to delivering a certain level of information as the project progresses, for example 1:100 drawings at stage C and 1:5 drawings at stage F. When working with objects, the level of information required will be filtered as a project progresses. This will be more than simply the geometric appearance of the object, but also instruction on the specification information required in the property sets. There will be clear allocation of design responsibility for each object and within each object early on in the process - for example, the structural engineer designing the performance of a staircase but the architect designing the aesthetics.

## Construction

When it comes to the construction of the buildings the contractors and installers will really utilise the information within the digital models. There will be less construction work on site and more assembly of pre-constructed

components. Models will feed digital production lines and whole elements or pods will be fabricated in factories so they are ready to arrive on site. Even at a basic level, doors will arrive on site cut to the correct size to allow adjustment for floor covering depth. Health and safety incidents will fall steadily due to construction in controlled factory conditions. Environmental impact during construction will also fall due to the ability to make decisions at the design stage that reduce waste on site.

The trend to contractor-led design on larger projects will continue. Contractors will gain advantages through being able to assemble design teams that can collaborate around clearly mandated digital work flows. Digital objects representing the “kit of parts” built-off-site will be provided to design teams to allow the non-aesthetic parts of the building to be optimised. This will allow the designers to focus their time on creating fantastic designs. On small and medium size projects there will also be greater collaboration from design teams that can offer an integrated service to clients – contractors that can most effectively work from this digital project information will have a distinct advantage.

The move to increase standardisation both across Europe and internationally will, in combination with structured data, allow language barriers to be broken down. For example, information compiled in Dutch could be communicated in German, English and French to different members of a project team. Traditional national boundaries will start to become less of an obstacle and there will be increased competition across borders.

### Operation

Technological advances in the automotive industry now mean that the user is alerted when parts of the car need servicing, windscreen wipers automatically turn on when it rains, assistance is given when manoeuvring or stopping in an emergency.

Future buildings will also inform the operators when maintenance is required. Within a building the services that consume energy will operate at their most efficient levels. There will be huge incentives for building owners to utilise this digital revolution – it will allow them to lower their operating costs over many years. Equally, where building owners rent out space to tenants the same

“Technological advances in the automotive industry now mean that the user is alerted when parts of the car need servicing... Future buildings will also inform the operators when maintenance is required.”

factors will make buildings with corresponding digital models far more desirable.

Where data can be collected across a portfolio of buildings then further analysis will be possible. The most efficient buildings can be compared with the least efficient. Building fabric and services can be compared so that the design can be improved on the next project and alterations can be made on the worst performing facilities. This will allow larger clients’ ‘kits-of-parts’ to be continually improved.

This won’t only be possible for the largest of building owners, but through the cloud where people are willing to share information the whole industry can learn from building operation. This continuous refinement of design and construction based on actual performance data will mean that outcomes continue to improve. Buildings will become more efficient to build and have a lower environmental impact.

### Conclusion

Digital construction is here to stay. The ideas described in this article will become reality. Maybe this will be by 2020 – or maybe at a more leisurely pace. But it will happen. What the UK industry must do is to make sure that it is leading the world. We have to continue to invest in our digital capabilities so that we can build better buildings at home and also be a net-exporter of services abroad. ●

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Below

The construction industry in 2020?



# Digital engineering

**Christopher Northwood**  
Digital Engineering Lead,  
Laing O'Rourke



“In future, practitioners will be split between those who manage their data and those who let their data manage them.”

Far right  
Standardised  
information-rich objects  
for consultants to use

Below  
Environmental impact  
and BIM

Laing O'Rourke's belief is that the key to successful digital engineering (Building Information Modelling) is the management of data. Aligning that data across multiple project stakeholders and project lifecycle phases provides a platform on which the model can be built. It enables smoother processes, better interoperability and improved data integrity.

The implementation of digital engineering protocols is fundamental to the way we work and has been rolled out across all Laing O'Rourke projects. We engage with the supply chain at the earliest opportunity to implement these protocols. If we can engage with the client's design team at tender stage, we will. The earlier in the process that these protocols can be applied the better, ensuring that the modelled 3D elements contain rich data beyond simple geometry.

### Setting the standards

We seek to understand the capabilities and capacity of the project team as soon as possible and to establish an agreed 'level of delivery', together with digital engineering responsibilities and accountabilities. The level of delivery will vary from project to project, but the key fundamental principle that data should be organised at every stage does not change. The project standards will detail at which stage of the project lifecycle the information should be produced, establishing a benchmark of delivery which sets the minimum standards expected, supporting specific deliverables of the project.

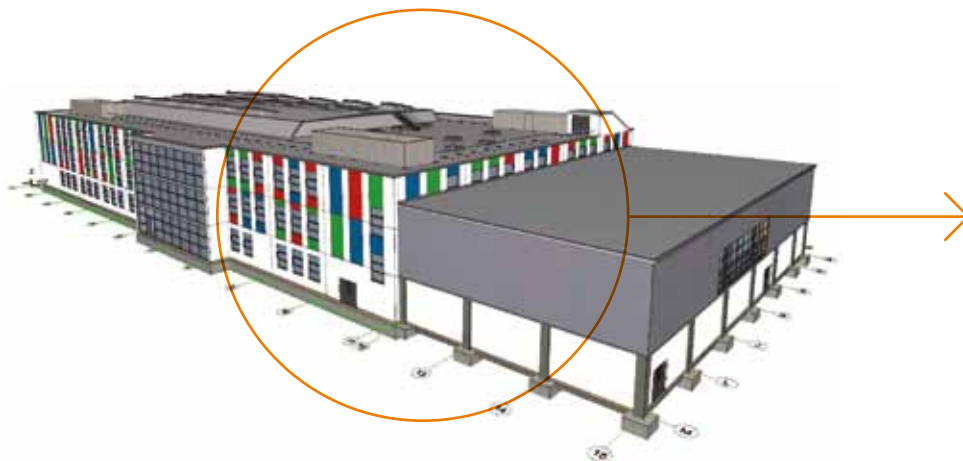
### Collaborative management

As a global engineering enterprise, we have widespread experience of working with project stakeholders (consultants, designers and the supply chain), who invariably use different software. Typically, we set up and manage the digital engineering environment across the majority of our projects and continue to support the integration of data within the model. For the sharing of individual model files and collaborative management of the resulting combined Building Information Model we use a project extranet. Over the course of many projects we have established a process for hosting model files in this way and maintaining an up-to-date combined Building Information Model which lends itself to the 'federated BIM model structure'. Hosting the model in this way enables us to manage the data during the delivery in a consistent manner such that it can be passed through Design for Manufacture and Assembly (DfMA) and into the operational asset phase.

The ability of digital engineering to influence these project phases affords project stakeholders the opportunity to optimise at every stage of the project lifecycle.

### Sustainable benefits

A key driver for the uptake of digital engineering in the future will be sustainability. The implications of design decisions from a sustainability aspect can be better understood earlier in the process if digital engineering is embraced. For example, the BIM can be used as a waste minimisation tool, providing



Outline Item	Quantity	Unit	Carbon (kg/m <sup>2</sup> )	Total Carbon (kg)	Total Carbon (tonnes)
Outline Item				912,375	912.3
Outline Item				912,375	912.3
Outline Item				912,375	912.3
Outline Item				91,400	91.4
Outline Item				91,400	91.4
Outline Item				9,810	9.8
Outline Item				7,100	7.1
Outline Item				5,911	5.9
Maximum depth = 0.00 m	262	m <sup>3</sup>	5.91	1,564	1.5

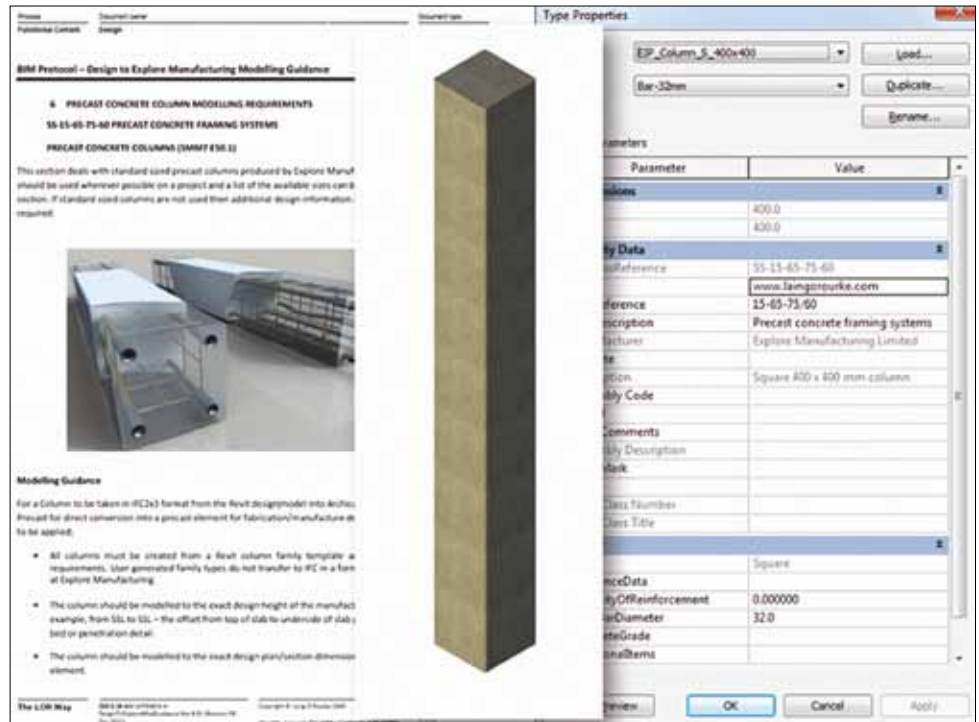
consultants with easily accessible material waste information that helps them make informed design decisions. Minimising waste results in reduced risk for the contractor and a lower build cost for the client. Significant volumes of construction waste could not only be diverted from landfill but removed completely from the construction process. Furthermore, the use of the waste generation report created from the model to automatically populate site waste management plans could help construction teams to manage the residual waste generated on a project. This will ensure that the fine balance between waste minimisation and effective waste management is achieved.

Another opportunity to leverage the model for sustainability purposes lies in calculating carbon performance. This is achieved at an early stage in the project lifecycle by appending embodied carbon values to commodities used within estimating assemblies. Whenever an estimating assembly is used to price a project, the associated embodied carbon will be calculated. The model can be used to create a detailed Bill of Materials, driving accurate calculations for the embodied carbon values of the asset. This data can then be presented visually by colouring up model components according to their embodied carbon levels.

A specialist software package that analyses the geometry of a building (shape and size, as well as the specific components of the building envelope) allows us to build an integrated energy model. By specifying the thickness and U-values associated with the building components, as well as infiltration rates, the heat transfer characteristics of the building as a whole can be calculated. When set alongside carbon calculation and waste minimisation, it becomes clear that the model has the potential to be the enabler for a holistic sustainability strategy based on reliable, structured data.

#### From concept to assembly

Laing O'Rourke also sees digital engineering as a key enabler for Design for Manufacturing and Assembly, driving the manufacturing process from concept to assembly sharing structured data between client, supply chain and contractor. Well managed data is of paramount importance in this process.



We work with our supply chain to develop the model in accordance with the methods described in the Laing O'Rourke digital engineering protocols. This enables us to produce a model export which is set up for use by our Explore Industrial Park (EIP) manufacturing facility in Nottinghamshire. The design model can be developed containing data sets and attributes for all manufacturing information accountabilities. The attribute data is used to populate the designers' drawings and schedules. These attributes are retained within the transferred Industry Foundation Classes (IFC) model and are visible in EIP's software package on import. This removes the reliance on 2D drawn data and enables the EIP team to convert the design intent model and progress this with supplementary detail into a manufacture model.

3D information is exchanged from the design consultant's model environment to EIP's software via IFC neutral file format. This provides a robust and enhanced information transfer, delivering project gains by omitting the duplication of model

processes and removing the risk of error from human interpretation of 2D drawings. The out-turn benefits of this approach are varied. Laing O'Rourke can achieve greater predictability of outcome in both cost and programme earlier on in the process, and realise efficiency gains. Early decision-making is made easier, as is the drive towards consistency and standardisation, both of which combine to help increase the uptake and application of defined manufactured components. For Laing O'Rourke, this is the apex of collaborative working through digital engineering: empowering clients, consultants and project teams to optimise projects through the use of rich, structured data.

In conclusion, digital engineering has the potential to offer great benefits to the industry, but only if the data is managed correctly. In future, practitioners will be split between those who manage their data and those who let their data manage them. This will manifest itself in the quality of the end product and the value derived from the model. ●

# BIM for Passivhaus Design: Delivering radical reductions in energy in use

Elrond Burrell  
Associate,  
Architype Ltd



Above  
Passivhaus design + BIM  
giving radical reductions  
in energy use

The UK Government's drive for BIM first arose out of a desire to cut CO<sub>2</sub> emissions in the construction industry. The 'Low Carbon Construction' final report published in 2010 by the Government's Innovation and Growth Team recommended implementing BIM to reduce CO<sub>2</sub> emissions a year earlier than the Construction Strategy published by the Cabinet Office in 2011, which set out how the Government intended to reduce costs by up to 20%.

At Architype, we use BIM to make our Passivhaus design process more efficient and to make collaboration more effective, so that we can deliver excellent buildings that radically reduce energy in use and CO<sub>2</sub> emissions, exceeding Government targets and client expectations. We have also pioneered the Soft Landings approach that brings the BIM process full circle so buildings are operated effectively and lessons from each project feed into the briefing on the next project. (See case studies in Soft Landings for Schools published by BSRIA and Usable Buildings Trust).

There are many definitions of BIM, but a key to differentiating it from 3D CAD is the information that the model contains. In a BIM process the right information can be made available at the right time and to the right parties. In this sense BIM provides quality assurance and plays an important role in the reduction of waste and repeat work at each stage of the building lifecycle.

Passivhaus is often described as "...the world's leading standard in energy efficient design", as it reduces energy requirements by around 75% compared to current Building Regulations. However, it is also a comfort standard covering internal temperatures, air quality and lighting. It sets comfort-based performance requirements for any kind of building while using the minimum amount of energy. The requirements are met through a combination of correct orientation for effective solar gain, high levels of insulation, high performance windows, airtight construction, eliminating thermal bridges through the building envelope, mechanical ventilation with heat recovery (MVHR) and modelling the design with the Passive House Planning Package (PHPP).

Passivhaus can also be seen as a quality assurance standard for energy performance and comfort. The right information is crucial for the energy model (PHPP), which is an

integral part of the design process. And a building must be built accurately to the design for it to be certified. The first Passivhaus buildings were completed in 1990 and data from a range of Passivhaus buildings completed since then demonstrates that measured performance in use is consistently equal to or better than the design predictions.

So several parallels can be seen between BIM and Passivhaus design, namely:

- Design and process are central, neither is a box-ticking compliance exercise.
- Information matters most, sexy images aren't enough.
- Rigorous model analysis and testing are crucial; the design is built virtually to get it right, then built only once on site.

At this point we should take a slight step back though and remember a few key points:

- Software doesn't design sustainable buildings, people do. Not PHPP, not BIM software of any flavour, but people with real knowledge, experience and understanding of how buildings work and how people use buildings.
- Just because we can use software to do something, it doesn't necessarily mean that we should. Software doesn't determine the purpose behind designing and building, people do. New and emerging BIM software allows us to imagine and design all kinds of fantasy creations, but we need to be sure that the software is working to support our purpose, not dictating the direction we go in.
- Just because something looks good, it doesn't mean it is useful. We have all seen fantastic CGI presentations and no doubt been shown rainbow-coloured thermal contour graphics, but these don't necessarily contain or communicate useful information that helps achieve the desired outcomes.

As George Box put it: "Essentially all models are wrong, but some are useful." We need to ensure the way that we implement and engage with BIM is useful with regards to the desired outcomes.

The Passive House Planning Package, as alluded to earlier, is in fact a building model. It is not a geometric / graphic model, as most people tend to think of BIM: it is an energy and comfort model that contains the right information to ensure the desired outcomes

“We feel that our children are more alert and attentive in lessons due to the amount of daylight in classrooms and the fresh air throughout the school. The fact that the new school is built to Passivhaus standards means that learning has been enhanced; our pupils love coming to school and enjoy their impressive surroundings. They are comfortable, secure and stimulated by their new environment; hence they learn very well!”

Sara Morris. Head Teacher,  
Oak Meadow Primary School

“Getting accurate numbers out of the model at any point in the process made it so much faster to check the building performance.”

Lee Fordham. Associate,  
Architype (project lead on several Passivhaus schools)

“Co-ordinating the M&E in 3D during the design stage gives me much greater peace of mind as a Passivhaus school starts on site. Unco-ordinated M&E works being resolved on site have traditionally been very stressful and impacted on the final energy performance.”

Lee Fordham. Associate,  
Architype (project lead on several Passivhaus schools)

are achieved (i.e. optimal comfort with minimal energy use). It is based on rigorous building physics and analysis of why buildings failed to meet their design performance targets. It makes conservative (accurate!) energy assumptions and it is open, parametric and instant.

We also use the geometric model in the design process in specific ways that are simple, useful and productive to ensure maximum benefit to the Passivhaus design process. These fall into two categories generally: Visual Interrogation of the model and generating Accurate Live Numerical Data.

There are three key aspects of Visual Interrogation of the model. The first is checking the thermal envelope in 3D by cutting sections, plans and details through the 3D geometric model and moving them in real time to check the continuity of the thermal envelope and identify any areas that need further attention, or where necessary, calculation of thermal bridging that can't be designed out. The continuity of the airtight envelope is checked in the same manner.

The second is checking and understanding the heat loss envelope in 3D. It is important to understand and minimise the areas where the building will lose heat; even the most elegant design is best understood in 3D to ensure soffits, protrusions, etc. aren't missed.

The third is inter-disciplinary coordination and integration. It is often where the architecture and structure and services are not coordinated, particularly in 3D,

that unexpected heat loss, energy consumption, CO<sub>2</sub> emissions, potential comfort issues and construction waste/ repeat work occurs. For example, structure passing through the thermal envelope introduces thermal bridging and other associated risks of condensation, mould, cold areas, drafts, etc. Excessive duct lengths or bends both introduce potential heat loss and can make it difficult to insulate properly. It can also complicate the construction, potentially leading to site waste and poorer performance.

Generating Accurate Live Numerical Data covers a number of areas that BIM is traditionally used for as well as some more specific to Passivhaus design and there are five areas we focus on specifically.

The first is generating Treated Floor Areas (TFA), which measures the heated inhabited spaces of the building and allows like for like comparison of performance between different buildings. The TFA is generated live from the model by using a calculation in a floor area.

The second is Ventilation Volumes, which are also generated live from the model by using a calculation in a floor area schedule. Indoor Air Quality is an important aspect of Passivhaus and accurate calculation of the volume of air that requires ventilating is critical for this.

The third is internal building volumes, which are automatically calculated in the BIM software and are necessary for calculating how airtight the building is when a blower door test is carried out.

The fourth is Heat Loss Areas, which are generated live and scheduled in the model. Needless to say these are critical for the overall energy performance of the building.

The fifth is Opening Areas (typically windows and doors), which are generated live and scheduled in the model. Similarly these are critical for the overall energy performance of the building.

So what kind of results are we achieving with our Passivhaus design process? The early data we have back from our completed buildings show that performance is indeed exceeding the design predictions. For example, Oakmeadow Primary School, a two-form primary school of 2,200m<sup>2</sup>, has two 65kW boilers installed, while the peak demand is only 25kW, meaning that the boilers, while only domestic in scale, are approximately five times oversized! Regardless of this, the gas bills after one full year of occupation are 90% less than those of the old building.

In our experience, BIM and Passivhaus work very well together. BIM can be used quite specifically in the Passivhaus design process for visual interrogation of the model and to produce accurate live numerical data. In this way BIM can make the Passivhaus design process more efficient and reduce construction waste and repeat work. A Passivhaus building produces excellent outcomes, including radical reductions to energy in use, radical reductions in CO<sub>2</sub> emissions and excellent user comfort. ●

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