CIBSE JOURNAL
The official magazine of the Chartered Institution of Building Services Engineers

June 2015
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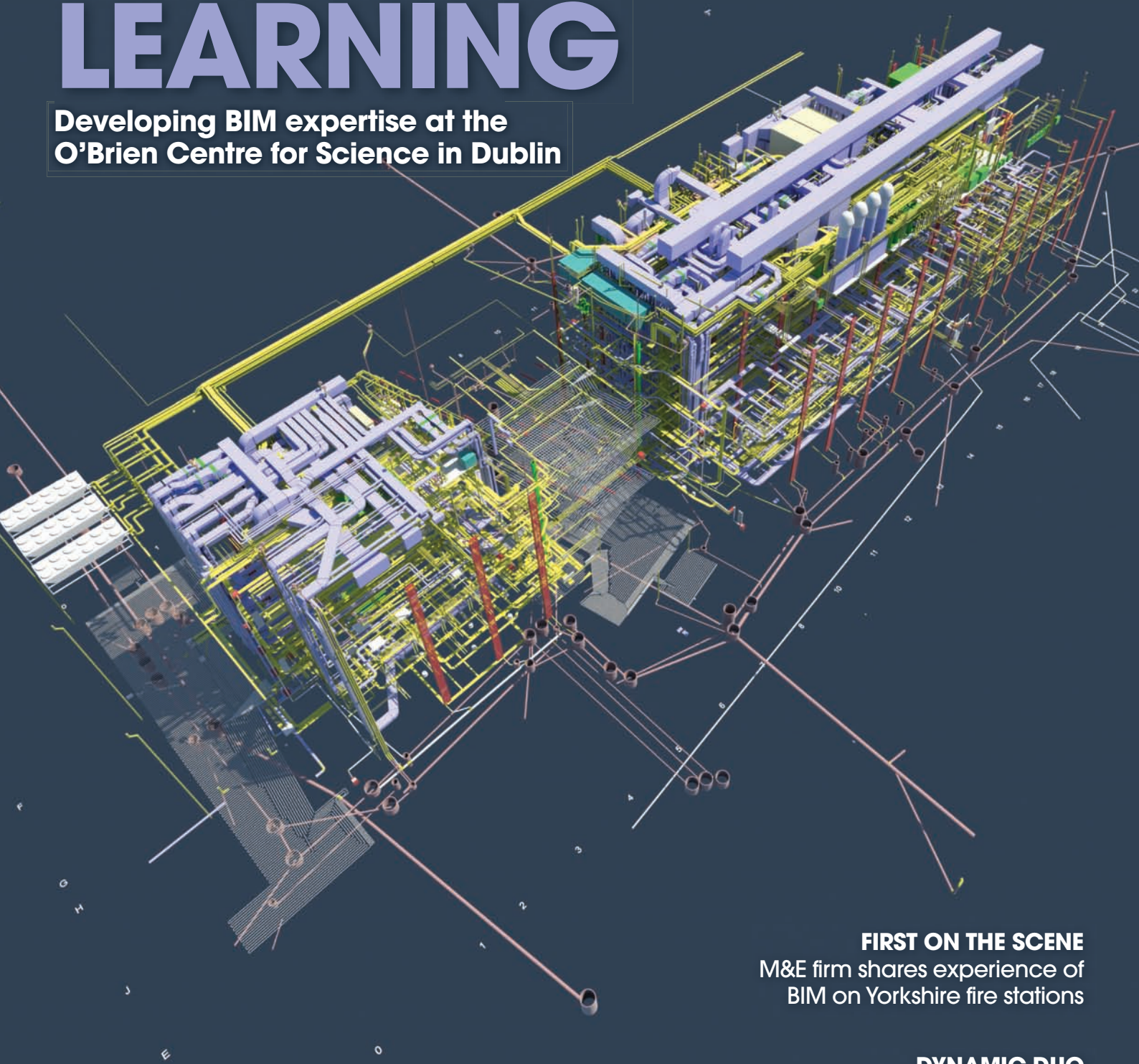
SEAT OF LEARNING

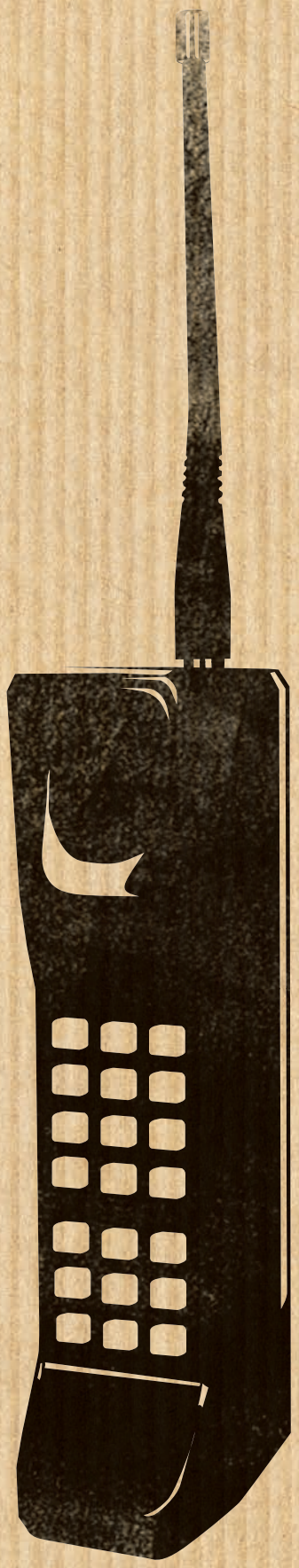
Developing BIM expertise at the O'Brien Centre for Science in Dublin



FIRST ON THE SCENE
M&E firm shares experience of BIM on Yorkshire fire stations

DYNAMIC DUO
Integrating BIM and thermal modelling

BIM SPECIAL



CIBSE JOURNAL

Supplement

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CIBSE Journal is written and produced by CPL (Cambridge Publishers Ltd) Tel: +44 (0) 1223 477411. www.cpl.co.uk 275 Newmarket Road, Cambridge CB5 8JE.

Editorial copy deadline: First day of the month preceding the publication month

Printed by: Warners Midlands PLC

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Tel: +44 (0) 20 8675 5211. www.cibse.org
 ISSN 1759-846X

Subscription enquiries

If you are not a CIBSE member but would like to receive CIBSE Journal, subscribe now! Costs are £80 (UK) and £100 (international). For subscription enquiries, and any change of address information, please contact Nicola Hurley at nhurley@cibse.org or telephone +44 (0)20 8772 3697. Individual copies are also available at a cost of £7 per copy plus postage.

The US annual subscription price is £100. Airfreight and mailing in the US by Air Business, C/O Worldnet Shipping NY Inc, C/O Air Business Ltd / 155-11 146th Street, Jamaica, New York, NY11434. Periodical postage pending at Jamaica NY 11431. US Postmaster: Send address changes to CIBSE Journal, C/O Air Business Ltd / 155-11 146th Street, Jamaica, New York, NY11434.

Cover image: UCD O'Brien Centre of Science

ABC audited circulation: 18,920 January to December 2014

BIM fits all sizes

BIM is not just for the big boys. Use of the digital process can benefit schemes of any scale, not just the mega projects with seven- or eight-figure budgets. New research has revealed that project teams' experience of working with BIM on small schemes is overwhelmingly positive (page 5) – but it also found that attitudes towards it were decidedly lukewarm among those who had not yet used the tool.

Those wary of BIM cited the lack of case studies on small projects as one reason for this. We hope to rectify this with our article on page 6, which records G&H Group's use of BIM on small fire station projects in Sheffield. It recounts the lessons learned and the benefits BIM brings by making teams collaborate at an early stage.

On a larger scale, Justin Keane explains how BIM was used on the £25.7m O'Brien Centre for Science, at University College Dublin, which required precise coordination between services and laboratories. Considering the BIM image on the front cover of this issue, it is hard to think of designing such a building in any other way.

The new NBS Toolkit, to which CIBSE contributed, aims to standardise BIM processes across the supply chain. Stephen Hamil introduces the online platform, which is launched in beta this month.

Alex Smith, editor
asmith@cibsejournal.com

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Suppliers respond to data challenge

It's just seven months until the 2016 mandate comes into effect, requiring the use of Level 2 building information modelling (BIM) on all public sector construction projects.

Adopting this collaborative, digital approach to constructing and maintaining buildings brings increased productivity at the design stage, and long-term savings throughout the life of the building or facility.

The government attributed £840m of savings on central public spending in 2013/14 to the increased uptake of Level 2 BIM and it predicts that, with widespread adoption, this figure will rise to an impressive annual reduction of £2bn in capital building costs. However, for BIM to achieve these dramatic efficiency savings, there needs to be widespread availability of BIM objects from manufacturers, in formats that meet industry-wide standards.

As one of the first heating manufacturers to embrace BIM, Remeha, in effect, created its own standards, from detailed research with clients, which helped us deliver the required product data for their Level 2 and Level 3 projects. However, as more manufacturers prepare to become BIM-ready, it is increasingly important to introduce uniform software and templates that will simplify, accelerate and standardise the introduction of manufacturer product data into BIM environments.

For this reason, we welcome the arrival of the CIBSE framework for product data templates (PDTs). Our experience has underlined to us the value of a quality BIM service for public and private sector projects, and we are adjusting our data in line with the new templates, ahead of 2016.

With clear evidence that BIM is already effecting positive change, this is a minor challenge for manufacturers, which will lead to major results by helping transform our notoriously inefficient construction industry.

James Porter is national sales manager at Remeha Commercial

remeha commercial

Five heating PDTs set for approval

● **Templates created for commercial and industrial equipment**

The Industrial & Commercial Energy Association (Icom) has completed BIM product data templates (PDTs) for five categories of commercial and industrial heating equipment.

The public consultation period on these PDTs has ended, and comments will be reviewed by CIBSE before the templates are approved as the industry standard. The product categories include air heaters, burners, gas and oil boilers, gas boosters and direct-fired storage water heaters, so engineers specifying these products will now be able to work with generic PDTs that are manufacturer-neutral.

PDTs are standardised product group questionnaires, which manufacturers will complete with their product information. The completed PDTs will then become product data sheets (PDSs) containing digitised information unique to each manufacturer's product.

Icom director Ross Anderson said: 'Icom has taken a pivotal coordination role in the development of PDTs for industrial and commercial heating products, acting as an interface and a moderator between CIBSE and the Icom membership.'

● Visit **http://bit.ly/1djTYWi** or **www.icomenergyassociation.org.uk/** for more information

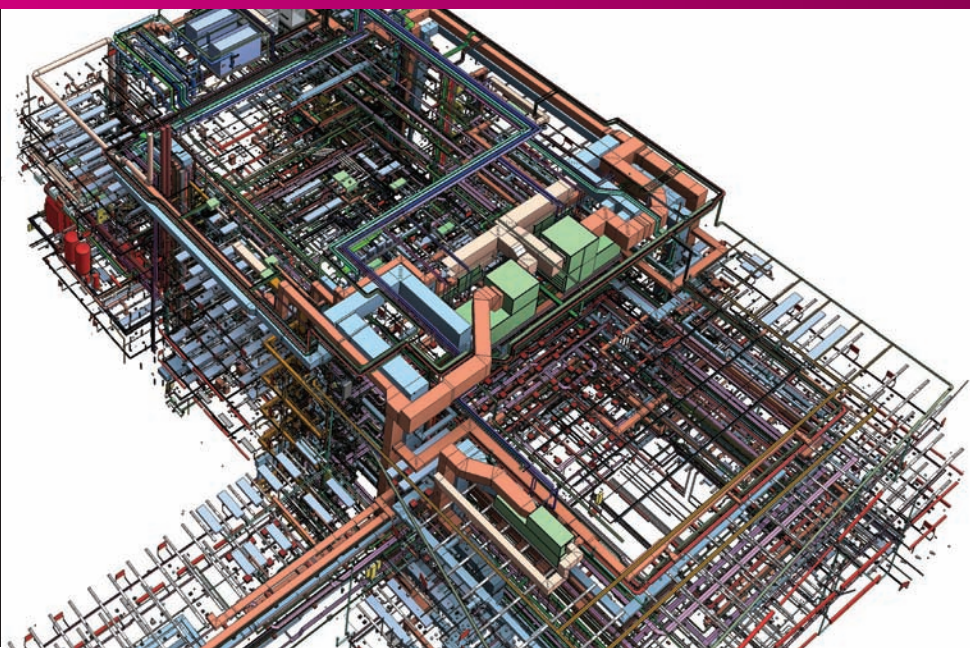
ARUP BROADCASTS BIM BENEFITS AT BIRMINGHAM CITY UNIVERSITY MEDIA CENTRE

BIM has played a crucial role in the new Institute of Art and Design at Birmingham City University.

The Parkside building contains the largest university arts and media broadcast centre in the UK, and includes seven interconnected radio studios, the largest fixed green-screen studio in Europe, editing and animation suites, and photography and fashion spaces.

Through the use of BIM, Arup engaged with the university to establish the functional requirements of spaces. This data was incorporated into the model and designers were able to check systems such as ventilation and power. The model also enabled greater coordination in the installation process.

The Arup team met the university's aspiration to have a functional FM tool combining 3D and system documents. This would not have been possible without a collaboratively produced BIM.



New tool to measure projects' BIM use

● **Arup's BIM Maturity Measure assesses implementation of process within projects**

Arup has launched a tool to assess the extent to which BIM is being implemented within its projects.

The BIM Maturity Measure is used by the firm to analyse how developed the process is in its construction schemes around the world, and has also been made available to the wider industry.

Users can assess BIM's use in 25 areas; the data generated can then be used to identify gaps in an enterprise's BIM implementation strategy.

Users fill in a short series of multiple-choice questions and numerical-scale rankings, so projects can be benchmarked against each other.

Arup director Michael Stych said: 'To date, BIM assessment has been complex and has been limited to high-achieving projects. Our BIM Maturity Measure tool aims to democratise assessment, enabling comparisons to be made across projects, quickly and easily. This will allow us to recognise where BIM has been used effectively, creating a code of best practice and helping to identify trends and training needs.'

Andrew Duncan, BIM manager for Arup in London, said that use of the tool had revealed a range of skills and experience among staff. 'We've had very mixed scores back from our first phase of testing,' he said. 'We've had some high scores on big government projects, but low scores in other areas. This allows us to focus support.'

Arup is concentrating particularly on specialist disciplines, such as acoustics and fire, in which BIM has had little penetration. Duncan said: 'We might have one discipline doing more BIM than another, and so we will recycle experience from a mature team into one with less BIM knowledge'.

'It's a way of tracking our internal processes and of starting a conversation with different parts of the construction industry to see what BIM means to them.'

Visit **http://bit.ly/1c4p0Qo** for the BIM Maturity Measure.

Research backs BIM for all projects

- **Study explodes 'myth' that process is only for large schemes**

New research has revealed that BIM can be effective on projects that are valued at less than £500,000.

This is despite findings in the NBS National BIM survey 2015, which found that implementation of BIM in small companies was significantly less than it was in larger firms.

In his research for his MSc dissertation at Brunel University, mechanical building services engineer at Kaizenge, Ryan Watt, interviewed more than 40 architects, building services engineers and BIM managers with a range of experience in using BIM. He found that those with no experience thought it was not suitable for projects of less than £5m, whereas those who had used the tool thought it was suitable for any project.

'This confidence in BIM's suitability within lower-value projects grew stronger the higher the individual's experience level,' said Watt.

'One respondent indicated that he uses BIM on all of his projects, and believes that investing in the process early pays dividends by reducing risks during construction.'

According to the research, people who had not used BIM blamed this on external factors, such as insufficient client and design-team demand.

Respondents who had implemented BIM, however, reported benefits such as improved internal efficiency, higher-quality documents and less design risk. The main advantage cited was the significant improvement in coordination among teams.

Watt's survey did not find any reliable evidence to justify the negative impressions many have of BIM, but found that the idea came from individuals who had little experience of it the process.

Watt said: 'I found many pioneers who had fully implemented BIM and are firmly in favour of its use on lower-value projects.'

The study found that BIM can be adopted appropriately on projects of all values and its unfavourable impression was based on 'myth and a lack of experience of BIM'.

Watt cited high capital costs, a perceived low demand, and the fact that most examples depict major projects as barriers to the uptake of BIM among small and medium-size firms, and on small projects.

How building modelling can aid the NHS

- **Digital health services could help revolutionise the NHS by monitoring both the health of patients and the impact of local environments on wellbeing, says BIM4Health task group member Janet Beckett**

The NHS report *Five Year Forward View*, published in October 2014, outlines the drivers and needs of the service, and the desire to capitalise on the opportunities the information revolution presents.

Digital health services, of which BIM is an important part, can significantly influence future decision-making about estate strategies and improve the efficiency of the NHS – helping to keep the treasured national service 'free at the point of use'.

Early in our BIM4Health task group discussions, I realised that – within healthcare – the end of the process is not with the facilities manager and soft landings, but with patient outcomes.

One of our team, Richard Pope, is a former clinician and now clinical director at Dynamic Health Systems (**www.dynamichealthsystems.co.uk**). His company provides a digital, supported, self-care service to primary care providers for patients with ongoing or multiple

health issues. The VitruCare service is prescribed by GPs and delivered via the internet. Used from any connected device, it enables the user to set goals to improve their health and wellbeing, and self-monitor the effects. Results have shown that it reduces contact with GPs by as much as 55%.

There is an obvious connection between this digital health service and the expanding market for fitness wearables – such as the Microsoft Band or the Surge Fitbit, which are wristband devices that track people's heart rate, activity levels and so on. Less obvious is the link between measuring and monitoring peoples' environments and their health.

There is a proven correlation between a drop in external temperatures and hospital admissions for influenza, chest infections and pneumonia. People with existing chronic health conditions are more susceptible and, by using digital healthcare, individual patients could be targeted and alerted to the potential dangers of a spell of cold weather. They could then adjust their environment and reduce the risk of having to go to hospital.

Other environmental factors could be monitored and improved using the BIM model and enhanced BMS in hospitals, care homes, sheltered housing and peoples' homes. Air quality, temperature, humidity and daylight can all impact on our wellbeing, and can be controlled to promote health goals.

BIM, plus the smart application of technology and digital healthcare services, could save the NHS money and improve its ability to look after all of us.

BIM4Health has published a video – aimed at clinicians – that introduces the concept of BIM. You can watch it at **http://bit.ly/1IlaE6G**

- More information is available at **www.bimtaskgroup.org/bim4health/**

JANET BECKETT MCIBSE is a CIBSE representative on BIM4Health, a CIBSE board member and director at Carbon Saver UK

BAPTISM OF FIRE

From 2016, any firm wanting to work on government building contracts must be able to work to BIM Level 2. M&E specialist G&H Building Services started gearing up for the technology in 2011, and is now using BIM on two fire stations in Sheffield. The company's **David Davis** relates the key milestones on the journey from rookie to expert

November 2011

We are invited to attend BAM Construction's Regional Supply Chain Partners' Annual Review, where we are introduced to BIM, which is something that BAM – one of our largest contracting clients – is using on the new Leeds Arena project. A demonstration is given of the benefits of BIM and a video of the virtual lifting of the main steel beams is shown. It looks impressive but we wonder if this would go as smoothly on site.

November 2011

Driving through Leeds later that month we notice that the main steelwork truss on the Leeds Arena is being lifted into position. We pull up at the roadside and watch for a while and are impressed that it is, in fact, very similar to the video seen months previously. We decide to look into BIM in more depth.

May 2013

The latest BIM-related story is in the news today requiring companies bidding for central government construction contracts to use Level 2 BIM from 2016.

This is significant and makes our initial investigation work into adopting BIM a really valuable exercise for the future.

Clearly, the M&E sector has to embrace this technology as soon as possible and, as a forward-thinking company, we want to be leaders in this. As such, we decide to press ahead and seek more information with a view to introducing it to the company.

August 2013

After months of monitoring the way BIM is progressing, we arrange a further visit to BAM Construction, which is holding another event on the use of BIM.

The advantages for M&E specialists like us are plentiful and from the demonstration it is immediately obvious how we could benefit.

For example, we could identify in detail the locations of HVAC systems and avoid surprises on site caused by changes in other specialist fields, such as structural steelwork.

An architect's impression of Birley Moor fire station

The early involvement of BIM will save time and money while ensuring any conflicting approaches by different parties can be ironed out during the pre-construction period.

Everyone's understanding of the scope of works is increasing and BIM will allow different disciplines to focus on shared targets and add more certainty to the procurement process.

November 2013

The G&H Group board gives the go-ahead to invest in BIM technology and to take steps to become BIM-ready.

A key point of BIM is that it is a collaborative process opening up the available software to user preference. However, as long-term Autodesk customers, we decide to invest in their Revit 3D modelling software and upgrade our hardware to suit. Two full BIM stations are set up in our design department.

February 2014

We appoint a BIM manager, Daniel Brook, who is experienced in AutoCAD design and is also a qualified HVAC engineer, which is a valuable and unusual combination but necessary, in our opinion, to bridge the possible gap between design and CAD.

Daniel completes a Revit training course in MEP services, as well as basic architecture, to become proficient in its use and build a foundation for development in 3D modelling.

April 2014

Following the training Daniel received, we are now testing the software, re-testing, and testing again to maximise its use in the M&E work we carry out. Its real capacity and scope is only now truly clear to see.

We discover we can model the M&E designs and use the software for pipe sizing, cable calculations and basic energy modelling. This has the potential to speed up design production, and integrate with different design software packages that are able to use BIM for detailed energy analysis.

We begin to put together our own BIM protocol based on the British Standards surrounding BIM.

May 2014

A major milestone. We are appointed to provide the M&E for BAM Construction's £5m scheme to build two fire stations at Parkway and Birley Moor in Sheffield – our first BIM projects.

BAM Construction provides us with additional support to develop our BIM strategy, which is a great boost.

July 2014

We are invited by BAM to attend the first BIM meeting with the structural contractor to complete the BIM execution plan.

The meeting explains how BIM will be managed, how we will collaborate and who will be responsible for each element.

Immediate benefits could be seen from having a full understanding of the building's features and realising how we can co-ordinate effectively. BIM design meetings are used to run through the co-ordinated models to understand where clashes are occurring or to highlight design changes that need implementing.

We soon realise that the design process on these projects will be longer than anticipated but – hopefully – the site installation will go smoothly and cause fewer conflicts with other trades.

Station doors at Birley Moor fire station...

...and how they appeared in the BIM model

September 2014

Co-ordination is found to be the key benefit of the BIM process. Throughout the project we use the modelling aspect to co-ordinate services and highlight pinch points often missed with a conventional 2D design. These are issues that can crop up during site installation and stop work while solutions are found, resulting in wasted staff hours and the need for extra materials.

We use the BIM model to design and manage builders' works openings through walls, which allows BAM Construction to make the walls with apertures pre-cut.

This saves time marking up holes, allows for a tidier installation and encourages more thoughtful services design, minimising the number of holes required.

January 2015

Site installation begins and already services are being installed in line with BIM-produced drawings, using holes cut and trimmed by BAM Construction.

We quickly realise that we need to ensure the site operatives understand how BIM works on site, as we find that dimensions on drawings are being overlooked as 'better routes' are found for services, which don't take into account the model building.

Once they realise why dimensions must be adhered to, the installation moves at full speed. Mechanical services can be installed knowing that allowance has been made for supporting electrical services, including crossover points.

This improves the speed of installations. It cuts down the 'mini meetings' needed on site for coordination when a clash occurs.

February 2015

We are now seeing the best features of BIM.

Collaboration promotes increased communication between the design team. Updates and changes to any element or trade are discussed so the team has an understanding of what is happening with a project, prior to installation starting.

The 3D modelling allows faster creation using intelligent software that anticipates, and adds in, fittings and joints that would otherwise need to be hand drawn and would not be as accurate.

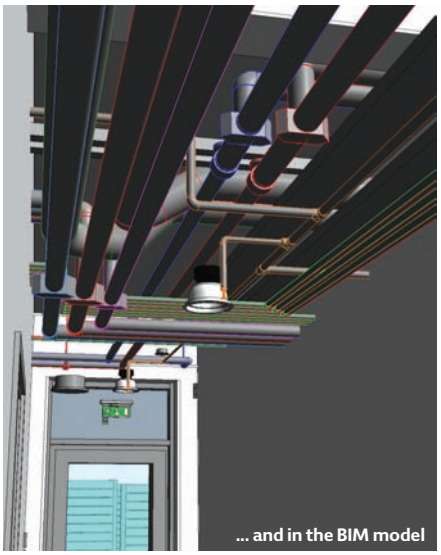
March 2015

As with all new technology, it evolves and there are areas for improvement with BIM.

The design process is longer than the traditional methods, which has an impact on the building programme.

An impression of Parkway fire station

Overhead services at Birley Moor fire station...



... and in the BIM model

Many manufacturers are already getting on board with BIM. However, a number are still without 3D model information available for use in BIM projects. This is not a major hurdle but it does take time to create a BIM-ready 'block' to use to level 2 standards.

We believe that as the 2016 deadline draws closer, more and more manufacturers will need to endorse BIM to allow easier design and modelling of their products.

April 2015

The two projects are progressing well and it is anticipated they will be completed earlier than the original programme. Considering the induction design period, it is testament to the advantages of BIM, which will only improve as the industry embraces BIM on future projects, refines its use and integrates it into all our schemes.

DAVID DAVIS is pre-construction director at G&H Group

> We believe that as the 2016 deadline draws closer, more and more manufacturers will need to endorse BIM to allow easier design and modelling of their procucts

LG's design tool calculates and check compliance for EN378

LG Electronics Air Conditioning and Energy Solutions Division's CAD simulation tool for direct expansion systems newly integrated function to calculate EN378 conformity comes to the aide of HVAC designers. The application, called LatsCAD, acts as an AutoCAD 'add-on' for 2D design of direct expansion systems saving up to 60% of design time.

This application has been specifically developed to cater for consulting engineering companies in the field of HVAC that want to increase the effectiveness and accuracy of direct expansion systems in their projects. It is designed with simplicity in mind.

Required conformity

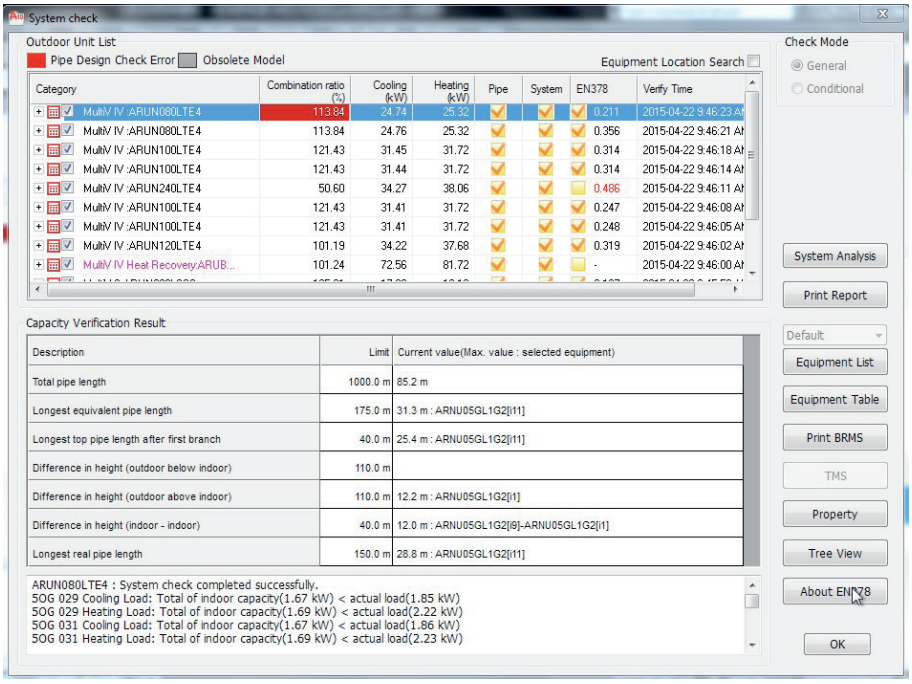
European Standard EN 378 limits the gas concentration (kg/m³) for buildings that receive people (for work, health, school, hospitality). The regulation became effective from 01 Oct 2000 – and is directly applicable in law in all EC countries. It states that all precautionary measures practicable shall be taken to prevent and minimise leakages of refrigerants from refrigeration and air-conditioning systems.

After a detailed assessment of the unitised air conditioning requirements for a building is completed, the designer's job is not yet done – further calculations need to be conducted in order to establish conformity to several European laws. One of which being the conformity calculation for the refrigerant charge limitations of EN378 Annex C using the following formula:

$$\frac{Amount}{Volume} \leq 0{,}44\ kg/m^3$$

Where the 'Amount' is defined as the entire quantity of refrigerant in the system in kilograms and the 'Volume' represents the volume of the smallest room through which refrigerant passes + the fresh air flow rate on 10 minutes duration given in cubic metres.

Designing air conditioning projects for buildings requires knowledge, skill and application. It can be complicated – even more so if designers have to add calculations for checking compliance with regulations. LG's investment is designed to ease the designer's burden.



LatsCAD calculates and checks compliance for EN378

The more complicated the project, the harder it is to complete. Imagine a multi-storey building – after calculating loads, selecting the air conditioning solution, and designing systems, there still needs to be an EN378 calculation for each system. LatsSCAD has recently integrated a function that calculates and checks compliance for EN378 Annex C automatically at system check simulation.

With this function, design time has been significantly reduced. For example, in the case study (above), a hotel building of seven floors with a 875 m² and 8 variable refrigerant systems has been designed in 6 hours, out of which 36 seconds represented the simulation time. After simulation, a designer can readily see which system is not EN378 conformant by the red highlighted numbers and an unchecked mark.

The provided comfort by confidence

LG Electronics Air Conditioning and Energy Solutions Division is driven to provide a total package to its partners, among whom designers are key. For designers, LG's commitment is extended into providing EN378 conformity simulations dedicated to its systems regardless of application. LatsCAD has evolved, in just two years to make the design of LG air conditioning systems easier and more accurate than ever before. It provides: precise system design, AutoCAD view, summary Excel report and conformity simulations.

LG Life's Good

For further information please contact monica.marza@lge.com

Thomas Gainsborough School IES model

THE SHARING

As the 2016 deadline for the introduction of BIM on central government procured construction projects approaches, **Andrew Brister** finds that engineers are reaping the rewards of sharing data early in the design process

Are you BIM-ready? It's not long now until the government-set 2016 deadline for mandatory inclusion of Level 2 BIM across central government procured construction projects. By creating, managing and sharing electronic models of the properties of an asset throughout its life-cycle, it is hoped that the industry can: find better solutions; reduce the amount of time and materials wasted; deliver projects faster; reduce risk; enhance sustainability; and achieve better whole-life performance.

The Cabinet Office and BIM Task Group have done their bit, producing the necessary standards documentation and contracts to support adoption – but has the industry taken these on board and understood how they all fit together?

'Over the past 12 months, we've seen an encouraging shift in the understanding of BIM in the UK,' says Sarah Graham, UK division head for building performance analysis software provider IES. 'The true value of BIM is becoming clearer, in that the ultimate outcome is not 3D CAD and coordinated services design, but the creation, capture, analysis and sharing of information throughout design, construction and operation of an asset.'

Process, not technology

Graham argues that, while technology is part of the solution, it needs to be backed up by a change in the building design process and in the mindset of the people involved. 'That takes longer and that's what IES is pushing for at the moment,' she says, 'because it's hard to get people to change the way they do things.'

Graham was among the speakers at a conference organised by CIBSE's Building Simulation Group – Linking Building Design Performance with BIM.

'At IES, our experience is that customers who get the process right see the technology fit together much better,' says Graham. 'The more information that is exchanged earlier in the process, the easier it is to do the iterative design, which ultimately delivers better buildings.'

For an engineer using IES software for dynamic simulation modelling for thermal,

> There will be teething problems when importing data from an architect's model, yet there are huge opportunities for those who know the ropes

Thomas Gainsborough School Revit model

energy and daylight analysis, there are massive productivity gains to be had from taking data stored in the architect's model. Too often, engineers build models from scratch. 'The benefits and savings only come into play when the various members of the design team know exactly what information they are responsible for producing, and when,' says Graham.

The first step is to set up an Employer's Information Requirements report (EIR) before any design is carried out.

Undoubtedly, there will be teething problems when importing data from an architect's model for use in dynamic simulation modelling, yet there are huge opportunities for those who know the ropes. 'These are exciting times, and there is big potential for CIBSE members to grasp the nettle by confronting the challenges and getting to grips with the issues as they see them,' says Graham.

Issues with the IES input for Thomas Gainsborough School

Building services consultancy CBG Consultants, with three offices across Oxford and London, has four engineers using IESVE full-time for thermal, daylight and CFD modelling. It also has a dedicated BIM modelling team.

'Typically, we would use SketchUp and ModelIT for the building geometry, but as BIM has become more prevalent, we have started using Autodesk's Revit,' says Zahid Ashraf, principal sustainability and energy engineer at CBG. 'Most architects are now developing Revit models, so we have started converting these into IES.'

CBG has carried out two case studies that highlight both the challenges and the benefits of the BIM process.

Thrayle House

Thrayle House is a large apartment building in Brixton, south London. CBG looked to import Revit models – including details of the apartments' balconies – into IESVE, to carry out overheating and shading analysis, and to work out ideal room volumes for the apartments.

'What we were really trying to achieve were the positives that come from optimising this process: the integration between software to get things running more quickly and smoothly; and getting the

Thrayle House architectural elevation

information between our internal BIM and IES teams flowing better, to increase knowledge between the two disciplines – which can only be a good thing,' says Ross Thompson, senior sustainability and energy engineer at CBG.

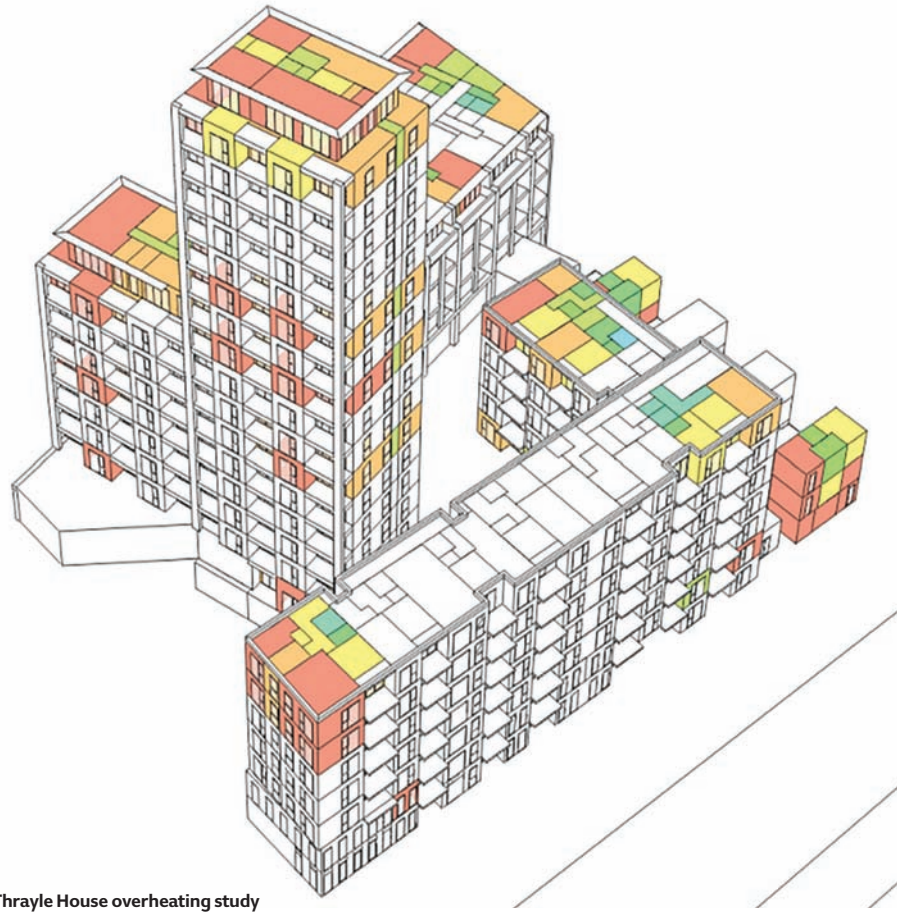
The team came across one immediate challenge: the architect had created the shell of the apartment block in one Revit model, with each flat represented in separate models, referenced to the shell. 'There was a huge amount of detail in individual apartments - too much detail – so, ideally, that would be simplified,' says Thompson. 'Also, the balconies didn't export. We would take those into IES as an obstruction.'

Also, when the Revit model was exported, room volumes were taken as too small. 'That's down to the way spaces are set up in Revit,' says Thompson. 'Some were attached to the ceiling and some were attached to the floor level, so we had to make sure that each space was tagged to the floor level in Revit to resolve the issue.' Internal walls were not quite touching the floor slab, either, so those had to be closed down.

Ultimately, though, the process offers substantial time savings over building your own geometry. 'By exporting the Revit model, you've already got room names, for example,' says Thompson. 'It sounds insignificant, but if you're working on a huge project in IES and have to enter the names for hundreds of rooms, that can take considerable time.'

Thomas Gainsborough School

CBG Consultants has examined the process in practice at Thomas Gainsborough School, in Sudbury, Suffolk. This is a large building in which structural openings have a fixed glazed panel next to a louvre providing ventilation to rooms. CBG was using IES to look at ventilation flowrates and possible overheating issues in the school.



Thrayle House overheating study

To do this, the data in Revit would, ideally, come into IES with separate areas for the glazing and louvres. 'The distinction between windows and louvres in Revit requires further investigation,' says Thompson. 'You need to work closely with the architect to make sure things are set up properly, so everything works smoothly when you export it.'

With separate BIM and IES analysts within the company, CBG has found it easier to educate its Revit engineers, 'giving them an insight into the kind of models that are required for IES,' says Thompson.

Clearly, there are issues at the interfaces between packages, but firms tackling the challenges now are finding that the effort is repaid with improved productivity over time. Of course, those firms that are making progress are best placed to take market advantage when BIM really takes off – and it's not just about the big boys.

'Yes, the larger companies are at the leading edge, driving the process through their organisation and supply chain. But we are seeing many small, specialist practices – which can be agile because they haven't got the overheads – rolling up their sleeves and seeing the benefits,' says Graham. Make sure your firm is one of those that's ahead of the competition.

The BIM Toolkit will accelerate the adoption of building information modelling and enable the industry to speak one 'construction language', says **Stephen Hamil**, director of design and innovation at NBS

TOOLS OF THE TRADE

Building information modelling (BIM) is a key part of the new-look digital construction industry, and there is now just a year to go until the UK government's mandate on the use of Level 2 BIM on centrally funded projects comes into force.

RIBA Enterprises was funded by Innovate UK to develop the NBS BIM Toolkit, which complements the Level 2 'suite' of software. In April, a public beta version of it was launched, after six months of intensive development by NBS and consultants from BDP, BIM Academy, Mott MacDonald, RICS, Laing O'Rourke, Microsoft and Newcastle University.

Firms and institutions across all of the construction disciplines were also consulted by the project team, to ensure the toolkit meets the needs of the whole industry.

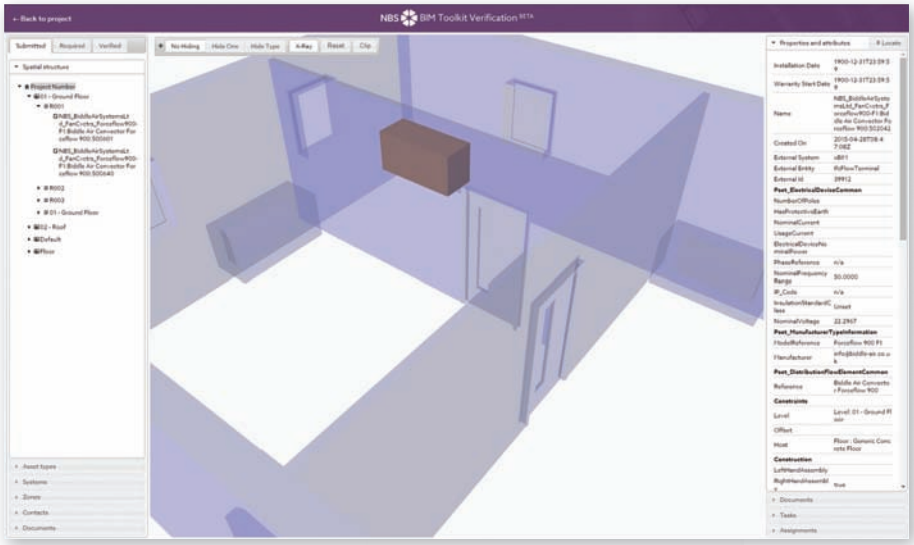
There is still a lot to do before its formal launch later this year, and it is important that as many people as possible from the public and private sectors – including clients, design teams and facilities managers – test the beta software and provide feedback. For those who haven't been following the BIM Toolkit story so far, it is worth recapping what it is and why it's important.

BIM for all

BIM is not an end in itself, but it is seen by the UK government as important to meeting the objectives set out in the Construction 2025 strategy published in 2013. These include:

- 33% reduction in construction and whole life-cycle costs
- 50% reduction in time from inception to delivery for new-build and refurbished assets
- 50% reduction in greenhouse gas emissions in the built environment
- 50% reduction in the trade gap between exports and imports.

BIM has been seen by many as the preserve of a small section of the industry, mostly those with an interest in IT or CAD. This misses the point and industry runs the risk of getting sidetracked by endless technical discussions.



A 3D model in NBS BIM Toolkit

Level of detail and level of information templates, and list of projects (right)

BIM is a behavioural-change programme that will enable and promote the closer integration of disciplines, which will lead to the improvements in project delivery that lie at the heart of the construction strategy.

The digital BIM Toolkit supports this by simplifying processes. It is intended to be intuitive and easy to use, enabling everyone to make BIM an integral part of their everyday work life, no matter what stage of adoption they are at.

The NBS project involved devising a standardised, digitally enabled classification system and a digital 'plan of works' tool. The result is a single, unified classification system and an easy-to-use web portal that guides users through the construction process.

The classification system is a new version of

> BIM has been seen as the preserve of a small section of the industry with an interest in IT. This misses the point. It is a behavioural-change programme

Uniclass, based on an international standard Framework. It was developed in collaboration with the RICS to align with NRM3, with which CIBSE Guide M is also aligned for classifying maintenance tasks.

The industry has a more unified data structure providing mapping and guidance so objects can be configured, at a project level, to have the correct multiple classifications where required. Alongside this, templates have been developed that set out guidance for levels of detail (LOD) and levels of information (LOI) for construction objects.

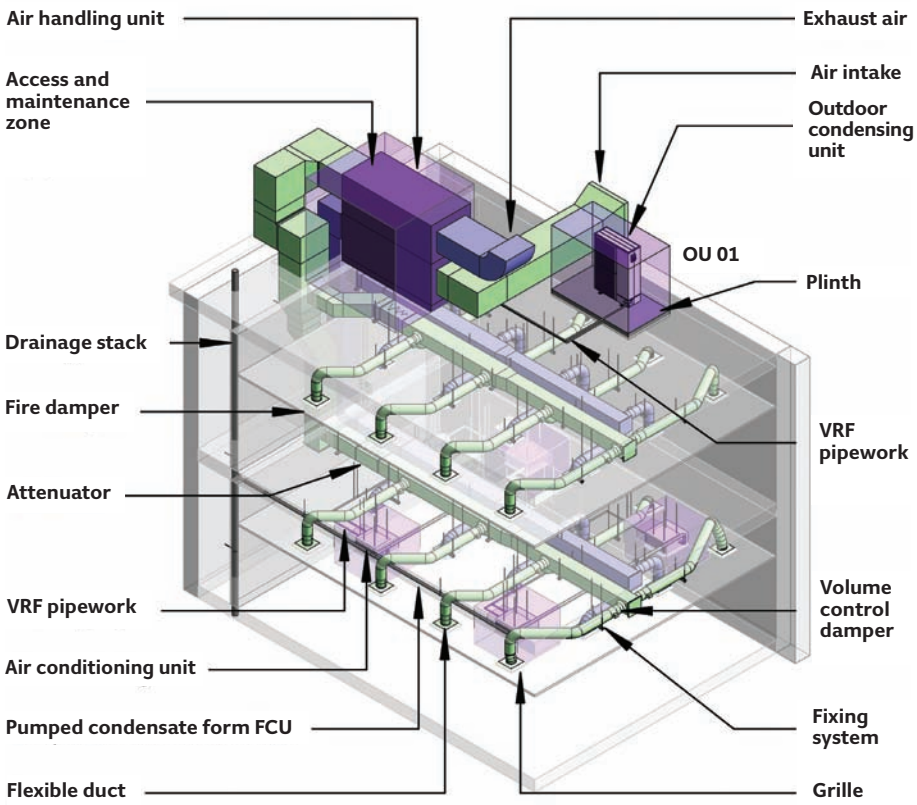
Initially, these will be spaces, elements, systems and products for building services engineering, as well as architecture, structural engineering, civil engineering and landscape design. They are available online in Industry Foundation Classes (IFC) and MS Excel formats, and form the 'construction language' that teams can use to define their information exchanges for a particular stage of a project.

The digital plan of work enables the project leader to define clearly the team, each member's responsibilities and an information-delivery plan for each stage of a project, setting out the 'who, what and when' in terms of documents, geometry and property sets. The aim is to reduce conversations and potential conflict dramatically, saving time and cost.

Furthermore, the BIM Toolkit is designed to work seamlessly with an employer's information requirements (EIR) document, enabling the client's 'plain-language questions' to be linked to tasks.

With the launch of the beta software, the whole industry can now use:

- An online digital 'plan of work' tool that models project participants, roles, stages, tasks and deliverables
- A library of more than 5,700 construction definition templates, covering all sectors of the industry. Some of these are based on data researched and developed by NBS over the past five years, while the infrastructure content and LOD reference guides have been built from scratch during the course of the project
- A new, unified classification system covering the entire industry and items of all scale, from facilities to products. In responding to industry comments on Uniclass 2, this has involved considerable consultation with industry experts
- Verification technology based around open-source software and buildingSMART open-data structures
- An API that allows software developers to work with the data schemas and the content inside the reference library
- An innovative delivery website that is responsive, working on all platforms, including mobile phones and wide-screen desktop devices



NBS model indicative of the LOD requirements for room air conditioning systems

The introduction of the toolkit will speed up the pace of BIM adoption. This is critical in the operation of buildings and assets, ensuring the models and information produced during the design and construction phases are fit for owners, operators and facilities managers.

The most recent NBS national BIM survey showed that only 12% of respondents – including several building services engineers – had passed a model on to someone with ongoing responsibility for the management of the building. A lack of client demand, meanwhile, was cited as the third most common barrier to adoption of BIM.

The aim of the toolkit is to create something that is simple and efficient, so the whole industry will recognise it as a smarter way to work.

> The digital plan of work enables the project leader to set out the 'who, what and when'… to reduce conversations and potential conflict, saving time and cost

- For more information about the NBS Digital BIM Toolkit visit **www.theNBS.com/bimtoolkit**
- For the NBS National BIM Survey findings, visit **www.theNBS.com/bimreport**

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BIM forces project teams to work in greater detail on design and installation in a virtual world before buildings go on site. MEP manager **Justin Keane** explains how contractor John Sisk benefited from the process on its first major BIM project at University College Dublin

PRACTICAL SCIENCE

PROJECT TEAM

- **Client:** University College Dublin (UCD)
- **Main contractor:** John Sisk and Son
- **Architects:** RKD Architects
- **BIM consultant:** ArcDox
- **MEP consultant:** Murphy Belton Consulting Engineers
- **Structural consultant:** Arup
- **Mechanical contractor and lead co-coordinators:** Leo Lynches
- **Electrical contractor:** Precision Electrical

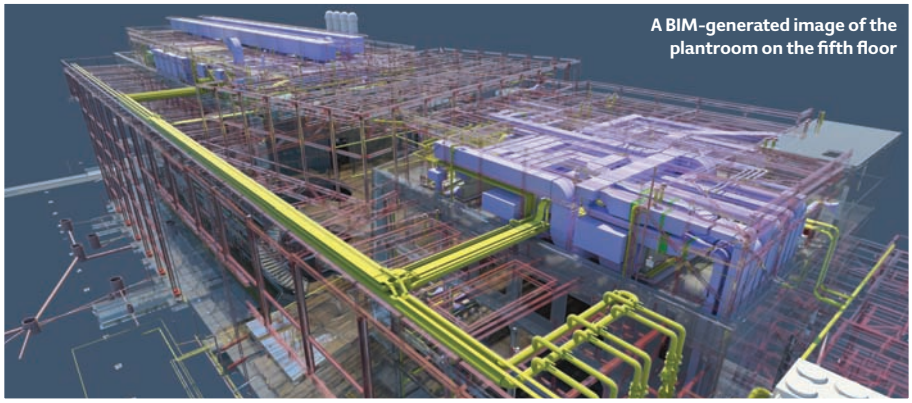
John Sisk's first major foray into BIM was as technical as it gets. The contractor used Autodesk Revit software on a €65m (£48m) science facility at University College Dublin (UCD), which included challenging designs for 21 laboratories. The value of MEP on Phase 2 of the O'Brien Centre for Science was €35m (£25.7m), which gives an idea of the complexity of the building services design in the five-storey, undergraduate teaching unit.

As it turned out, BIM was the perfect tool for John Sisk to trial on the O'Brien Centre, because it enabled the contractor to identify potential installation and design issues in the complex laboratories and plantrooms. These would have been picked up much later if the team had not been collaborating through BIM and had, instead, been using traditional 2D drawings, with which clashes are much harder to detect.

The 19,000m^2 facility features biology teaching laboratories and support spaces, classrooms and offices on the first and second floors, while a 250-seat auditorium, restaurant and kitchen occupy the ground floor. Floors three and four are shell and core, and all major plant is located on the fifth floor. This consists of tri-generation, primary supply and return air headers with an extensive heat recovery system using AHUs and Econets, district heating and photovoltaics. The project is rated BREEAM Excellent.

Having been part of the construction team

University College Dublin's O'Brien Centre for Science



A BIM-generated image of the plantroom on the fifth floor

for previous, technically challenging, projects with John Sisk – including The Convention Centre Dublin – I was able to compare a project that had used BIM with one delivered without it. This article will reflect on the operational and cost benefits of BIM to myself, as the MEP manager, John Sisk, the main contractor, and the project team.

The introduction of BIM was a steep learning curve for the project team, which included mechanical and electrical subcontractors. The design team did not initially work in BIM, the onus for coordination was taken on by John Sisk from 2D IFC design drawings to a fully coordinated BIM model. New processes had to be implemented for the timely delivery of 'for construction' coordinated and 'builders work' drawings, and we had to create and implement the best BIM protocols.

> In a 2D world, we cannot be sure of each team member's ability to interpret and understand complex drawings

Before coordination drawings had been issued for formal approval, I set up regular workshops for the project team that consisted of virtual 3D walk-throughs of the space under coordination. We reviewed mechanical and electrical plant locations, access requirements, pump heights and locations for maintenance, as well as primary and secondary MEP services routes (vertical and horizontal), and looked at clashes yet to be resolved. The client, UCD, and the campus FM team also attended these workshops. They have vast experience and knew exactly what they wanted.

Issues were raised and recorded, and modifications made to the model before it, and the drawings, were formally issued for approval. As a result, there was a much lower level of adverse comments on the coordinated drawings than would normally be expected. The workshops also helped to communicate the plan to the project team.

Director at mechanical contractor Leo Lynch, and former chair of CIBSE Ireland, Brian Sterling, confirms that the workshops were useful to his team. 'As much as it benefits the client to see and comment on the finished plantrooms and risers prior to any works undertaken,' he says, 'it is equally beneficial to show the site personnel exactly what is to be built.'

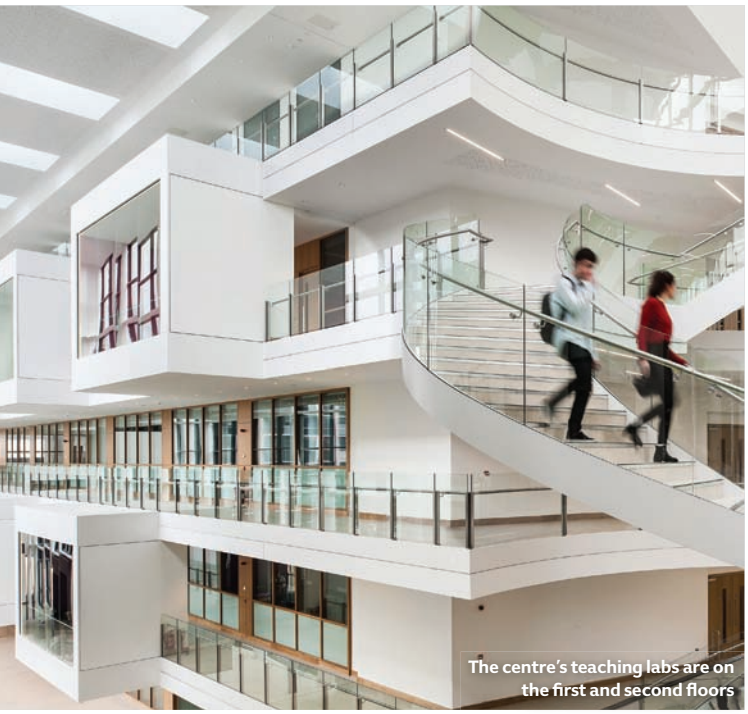
When it comes to resolving major clashes, the MEP engineers and sub-contractors have a silent, but invaluable, partner in BIM. Architects don't always understand the issues and practicalities that arise during the design and installation of MEP services on technically challenging projects. BIM forces these issues to a head. If it's clash-free, it's working; if there are conflicts, it is not. What could previously be swept under the carpet in 2D and left for someone else to deal with – usually the contractor – can no longer be hidden away.

In a 2D world, we cannot be sure of each team member's ability to interpret and understand complex drawings. People come from different backgrounds and are at various stages in their careers.

As an MEP manager, I was confident leaving the 3D workshops that the information had be clearly communicated and – more importantly – clearly understood by the project team through the higher level of communication provided through working in BIM.

Critical sequence

The installation of the laboratories at the O'Brien Centre was always going to be a challenge, and looking, in detail, at the logical sequence of the construction activities for one lab was critical to the success of the other 20. There were difficulties in the sequence of work for the laboratory furniture and equipment fit-out, which BIM helped to overcome.



The centre's teaching labs are on the first and second floors

The completed services

The first- and second-fix MEP services needed to be completed on a certain date but they couldn't be finished. The chemical extract, laboratory gases, water, waste, BMS, and electrical services also needed to be tied into laboratory furniture through vertical umbilicals to fume cupboards and rotovap units. These were to come much later in the construction, when the labs were clean and ready for such sensitive equipment.

The issue was resolved by obtaining suppliers' drawings (BIM families) of laboratory furniture, fume cupboards and rotovap, which could be added to the model (see Figure 1) with help from BIM consultant ArcDox. We were then able to pinpoint the locations for the initial high-level terminations of all services before the fit-out, and to indicate the required builders' work openings for the drainage. A set of drawings was produced and the information added to the builders work and coordinated drawings. As a result, laboratory furniture, fume hoods and rotovap units were installed without the need to move services or recore openings.

Sterling says BIM must be regarded as a live model: 'To achieve the full benefit, all disciplines need to work within the model and have the model updated constantly during the construction period.'

Fit-out requirements

The fit-out to the 'shell and core' third and fourth floors needed to be considered for vertical and horizontal distribution of services, and so that the associated additional plant could be installed on the fifth-floor plantrooms. We placed the extra plant – and the primary services runs from it, down the risers, to the third and fourth floors – into the BIM model. We were, thereby, able to demonstrate that future fit-out considerations were being met.

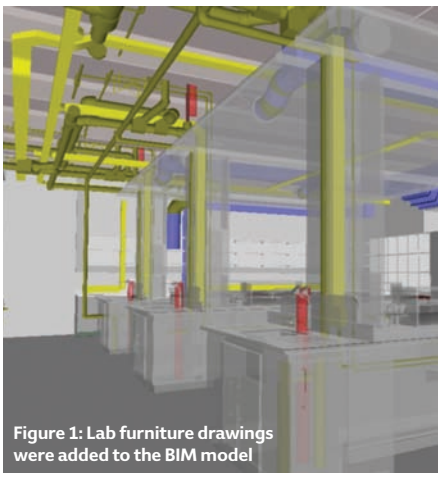


Figure 1: Lab furniture drawings were added to the BIM model

It's often reported that BIM produces a saving by reducing time spent on site management, but this is only if time and effort is spent on BIM management and installation earlier in the project life-cycle.

Building a coordinated, workable model requires a level of understanding of the practical installation and maintenance of MEP services that far exceeds that of the traditional CAD operator.

Subcontractors' BIM technicians are issuing to site exact coordination dimensions – such as bottom of pipe and bottom of duct – so must have an overall understanding of the drawings and the potential installation issues. Site installation teams have to trust the ability of the technician to get it right; failure could result in main services runs not aligning, which will have a negative impact on costs, the programme and the project team. There must be a manager to oversee the virtual installation and the BIM technicians before any work on site.

The amount of work done at an early stage using BIM can be evidenced by the low number of requests for information (RFIs) – queries over construction drawings that can add cost and delay projects. On the complex UCD scheme, there were no more than 40 mechanical and electrical RFIs; on projects where BIM hasn't been used, this figure can be in the hundreds. This massive reduction can be attributed to a significantly better form of communication across the project team.

Summary

BIM is revolutionising the construction industry. On the O'Brien Centre project, it led to much greater understanding between project team members, while 3D virtual workshops and walk-throughs gave confidence to the client.

We could test installations in the model to prevent clashes, which meant the elimination of abortive works. BIM also made it much easier to plan and coordinate services routes for future fit-outs and development phases.

These benefits are in addition to the cut in RFIs. With BIM in the toolbox, there is less timewasting and more action.

JUSTIN KEANE MCIBSE was the MEP manager at John Sisk. He is currently employed by KEO International Consultants, in Qatar, which will use BIM on major projects associated with Qatar's National Vision and the 2022 World Cup