

GOING DIGITAL

A guide for construction clients, building owners and their advisers.



CONTENTS

P.02	FOREWORD
P.03	ABOUT THE AUTHORS
P.04	PREFACE: WHY THIS GUIDE IS NECESSARY
P.06	MODULE 01. BECOMING AWARE
P.10	MODULE 02. STRATEGY MAKING
P. 14	MODULE 03. EQUIPPING THE CLIENT OFFICE
P. 18	MODULE 04. FORMALISING THE USE OF DIGITAL WORKING
P. 22	MODULE 05. REVIEWING TEAM FORMATION
P. 26	MODULE 06. DECISION SUPPORT REQUIREMENTS
P. 30	MODULE 07. OPERATION AND MAINTENANCE REQUIREMENTS
P. 34	MODULE 08. SETTING STANDARDS
P. 37	CONCLUSION

WRITTEN BY
RICHARD SAXON

WITH CONTRIBUTIONS FROM
KESTER ROBINSON & MAY WINFIELD

UK BIM ALLIANCE

DEPLOI: BIM STRATEGIES. OCTOBER 2018.

FOREWORD

BY ANNE KEMP



BIM (put simply, better information management) - as conceived by the UK with its original BS/PAS 1192 standards suite - is a foundational step on the journey to digital transformation. Without due care and attention to the digital data which underpins further transformation, our physical infrastructure will remain dumb and insular.

This report helps clients in the built environment sector to understand "BIM" from first principles - making it relevant and accessible. It is an important addition to the increasing knowledge bank that the UK BIM Alliance is building up to help industry implement BIM as business as usual. This is an essential part of the armoury in transforming our built environment for a resilient and sustainable digital age.

It is important that the UK BIM Alliance remains grounded. We are the anchor to allow industry to move forward through troubled and rapidly changing times, knowing that there is a consistent and trustworthy means to get first principles in place which are flexible but reliable. This is not about throwing away the past, and rushing ahead to the next bright new thing. It is about continually horizon-scanning to ensure we remain on course. And it is

about consolidating on what already exists and getting that right - which in itself may require change.

But we don't do this alone. Our work is for the industry, by the industry - and we are working alongside BSI and CDBB to develop a robust, clear Guidance Framework which allows UK industry to transition to international standards which facilitate trade around the world.

I very much hope that "Going Digital" can be the first port of call to those clients who are new to or are confused by this "BIM" phenomenon. It should bust some of the myths - managing our information better applies to all of us. And with a healthy dose of common sense is achievable for all of us. But clients are a lynchpin - and this is why "Going Digital" is so important as base guidance for clients.

My thanks to the authors - your efforts are hugely appreciated. And to the readers - I hope you find the "Going Digital" useful on your journey to digital transformation. Good luck!

Dr Anne Kemp
Chair, UK BIM Alliance
Director, BIM Strategy & Development, Atkins

ABOUT THE AUTHORS



RICHARD SAXON Main author

Richard is an architect and surveyor with long experience of supporting clients in getting what they need. After a career at BDP, climaxing as Chairman, he has focussed on client advice at Consultancy for the Built Environment. He was on the Government BIM Steering Group during the formation of the BIM Toolkit in 2012-13 and wrote 'Growth through BIM' for BEIS, published by the Construction Industry Council. He also wrote 'BIM for

Construction Clients' for NBS Publications, released in 2016 to coincide with the government mandate to use BIM. Since 2015 he has worked with Deploi: BIM Strategies (deploi.co.uk). Richard is also chairman of JCT Ltd, the contract-writing body, and a non-executive director of BLP Insurance. A long-term enthusiast for industry reform, he was made a CBE in 2001 for services to architecture and construction. www.saxoncbe.com



KESTER ROBINSON Contributing author to Module 3

Kester qualified as an architect at the Bartlett school in London in 2004 and spent six years in the USA at Gensler, the world's largest architectural firm. Having mastered the digital modelling software Revit, he returned to the UK in 2012 and formed Deploi: BIM Strategies. This is a consultancy firm designed to assist architectural practices in navigating the increasingly digitalised working

environment. He has developed a suite of architecturally-informed assets and protocols to streamline office workflows, drive productivity and adhere to emerging industry standards. His consultancy is both strategic and tactical, from establishing change programmes to training hands-on users. Deploi now also advises clients on how to ask for digital services and to realise the benefits. kester@deploi.co.uk



MAY WINFIELD Contributing author to Module 4

May was one of the first lawyers to explore the impact of BIM and is a recognised specialist, advising consultants, contractors and insurers and preparing bespoke BIM documentation. She has spoken widely on the subject and wrote the award-winning Society of Construction Law paper 'Building Information Modelling: The Legal Frontier- Overcoming Legal and

Contractual Obstacles'. Her 'Winfield-Rock Report', written with Sarah Rock on this topic was published by the UK BIM Alliance in February 2018. May is chair of BIM 4 Legal, set up to support lawyers in getting an understanding of the field. She is also a committee member of BIM 4 FM and a core member of the 4D BIM Group. maymlooi@gmail.com @Buildlaw_Arttea

Nothing in this guidance constitutes legal advice or gives rise to a solicitor/client relationship. Specialist legal advice should be taken in relation to specific circumstances.

The authors acknowledge the help of others in preparing this publication, especially Anne Kemp, Rick Hartwig, Matthew Knott and Cristina Salvi of the UK BIM Alliance.

PREFACE: WHY THIS GUIDE IS NECESSARY

Digital methods offer a step-change in value and productivity for clients. But these methods are not yet being adopted by mainstream private and public clients because they don't perceive that value. Clients are also put off by the effort that seems to be required from them and by demands for extra costs from suppliers asked to work this way.

The UK BIM Alliance was formed to help the industry and its clients to make the use of digital methods 'business as usual' by 2020. This guide focusses on the message to clients and to their advisers. It sets out a path for clients into the use of Building Information Modelling (BIM) and its related techniques. It uses plain language rather than the jargon which has sprung up amongst suppliers. It demonstrates the return on investment available and the nature of the investment required from clients. It offers eight steps into BIM usage which can be taken in selected order and not all of which will seem relevant to all clients. A start is possible after the first four steps.

VALUE TO CLIENTS

BIM, as practiced in the UK, has become the world's leading approach to digital built environment. The standards devised for the Government's so-called 'Level 2 BIM' are now being translated into European and world (ISO) standards. They are powerful tools for designing better buildings and infrastructure, delivering them faster and to higher quality, and operating them far more efficiently and effectively than before. The client's role is central to realising the full value of this approach. Some clients now 'free ride', allowing their teams to use BIM for their own reasons but not pitching in to define what they need from it. These 'passive' clients get some value as the team saves time, improves coordination and avoids defects. But 'active' clients can get far more benefit and avoid new risks created by inadequate clarity. This guide shows how.

CROSSING THE CHASM

The challenge for the built environment industry in engaging the majority of clients

is well described in the book 'Crossing the Chasm' by Geoffrey Moore⁰¹. Moore studied the problem that always faces technologically-led innovations in moving up the marketing 'adoption curve' from the Pioneers and Early Adopters to the Early Majority (see Figure 01). The reason that pioneers and early adopters buy into an innovation is that they are enthusiasts, intrigued by the promise of the technology even before there is a proven business case. The early majority market is not interested in the technology itself, nor in unproven promises. It needs to see a business case, based on demonstrated return on investment. Technology innovations regularly fail to cross the chasm between the early adopters and the early majority by not changing their message to suit.

That is where we are with BIM for clients, and with the related potential of the Internet of Things, Big Data and Artificial Intelligence to make built assets more productive. This guide aims to help bridge the chasm.

PLAIN LANGUAGE

When the Government's then chief construction adviser, Paul Morrell, recommended in 2011 that public policy should be based on the use of Level 2 BIM by April 2016, he warned the industry to keep the complexities of BIM to themselves and not to burden clients with it. That did not happen. The Task Group formed to develop the toolkit of standards and guidance created a special language for users, to enable precision. This language named new features but also renamed familiar ones, making the whole subject arcane and opaque to industry outsiders, which most clients are. This guide sticks to the familiar language used by clients, consultants, constructors and operators for decades.

JUST THE INFORMATION NEEDED

The government had a clear view of what it wanted from BIM. As the owner and operator of the facilities that it buys, it was concerned to take a long-term, whole-life view of asset performance. Reducing facility operating costs and enabling increased occupier effectiveness are part

Innovation adoption curve

AFTER EVERET: ROGERS 1962-2003

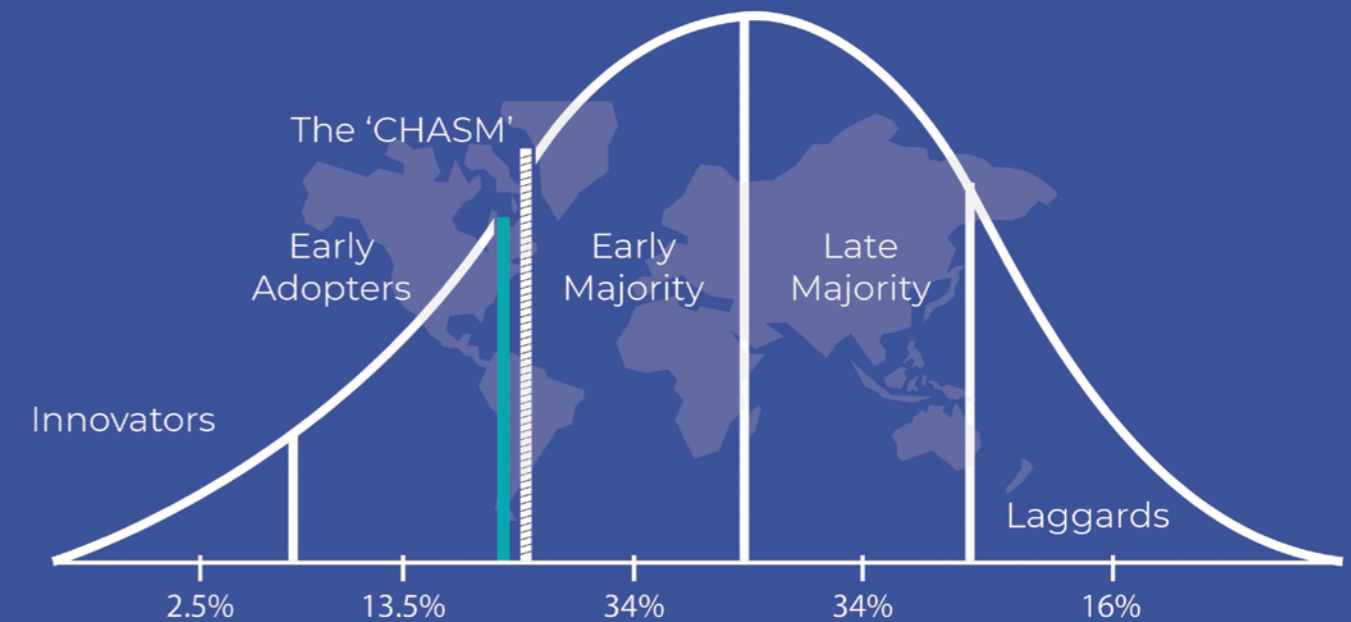


FIGURE 01
Innovation Adoption Curve. After Everett Rogers 1962, 2003, as used in Crossing the Chasm.

of their goals, along with reducing capital costs, time to completion, carbon emissions and reliance on imports. The package called 'Level 2 BIM' includes whole-life features which may not apply to all clients, or which they are not ready to consider. Government BIM also asks for regular information supplies from delivery teams to support decision-making processes in client and stakeholder organisations: not only should design, cost and time information be available but also anything else that meets defined stakeholder needs at decision points, to smooth progress. This too may be more than many other clients need.

STEP BY STEP

The approach taken by this guide is to be incremental. Clients can go as far as seems sensible for themselves, holding back from steps not relevant to them, or not currently worth taking. It won't necessarily be full 'Level 2 BIM', but it can still deliver far more than passive client-ship. The approach taken here is set out in eight steps, the first four essential, the rest optional:

1. To become aware: just knowing what BIM really is and what it can do for similar clients opens up discussion;
2. To make a strategy: Top client management needs to decide what is worth doing and how to progress, as part of a project or to make a context for future projects;

3. To equip the client office to work digitally: depending on the strategy chosen, clients will need to invest in their capability to instruct their team and to work with digital data;
4. To formalise the use of digital: Client instructions need to be given to appointed consultants and constructors, to avoid new risks and to define requirements contractually;
5. To re-consider team formation: BIM works best when compatible teams are formed and stay together, often through framework agreements;
6. To define decision-support needs: brief-making in a digital environment adds information requirements to the matrix of design, cost and time factors, in order to support the decisions of all interested parties at each stage;
7. To define operation and maintenance needs: Where the asset will be retained and managed by the client, BIM can transform facility performance if the required O&M data is requested up front;
8. To create useful standards: Digital models can be made of elements required repeatedly by clients, such as standard rooms or preferred products, for time-saving and re-use.

Each module of this guide looks at one of these steps in more detail.

⁰¹ Crossing the Chasm: marketing and selling technology products to mainstream customers. Geoffrey Moore. 3rd edition 2014. Collins Business Essentials.

MODULE 01.

BECOMING AWARE

The most mentioned question from clients in surveys of the industry is: "What is BIM?" It is not therefore surprising if clients, and many of their advisers, are not really aware of the meaning and significance of digital working methods. The technique has been in use for at least 15 years and has been Government policy since 2011. Yet it still resists easy description.

BIM (literally Building Information Modelling) is essentially team-working with structured, shareable information

in digital form. Contrast this with analogue working, where project information is exchanged in drawn and written form. Such information was inherently full of discrepancies, ambiguities and omissions, with each party to the project likely to be using their own version of the information. Even with the best document management, risks were high due to uncoordinated design, changes on site and disputed facts. All parties carried significant contingency sums to cover the uncertainties involved.

The power of digital information

Digital information, properly structured, can be read by machines as well as by people. It can thus be automatically checked for accuracy and completeness. The team's shared data forms a 'single source of truth' for everyone and a 'golden thread' of continuity across the life cycle. Beyond the dramatic reduction of risk that this fact creates, digital information can be visualised, to give stakeholders a clear 3D idea of proposals before they are committed. Many more options can be studied than by traditional means and performance can be simulated to prove that goals will be met. Costs and time sequences can be studied, potential energy use optimised, health and safety better managed and construction rehearsed. Offsite fabrication should be simpler to organise. The completed facility should arrive sooner, with few defects and with a database which enables it to be operated and maintained far more effectively. Capital and whole-life costs should be reduced. Coupled with digital sensor-based control, a physical asset can have a 'digital twin', a virtual duplicate of itself which, with artificial intelligence, enables the facility to be aware if anything needs adjustment in order to operate as envisaged and to deliver the outcomes intended for owners and occupiers.

Of course, not all clients will be interested in all the benefits available or be prepared to invest in the costs associated with them. A client for a small, one-off project may not feel up to engaging with digital working; a property developer who usually sells the completed building to investors may not yet see a possible market for the facility management database. They may also not be willing to enter the BIM process before obtaining the all-important planning permission and funding. Conventional housebuilders may consider that they have a suitably sophisticated process already, paced by the rate of sales.

Private and public bodies who build regularly and retain their assets for use are the most likely to find digital working a very rewarding innovation. Examples would include industrial and commercial corporations, developers who retain and manage buildings, build-to-rent housing providers, including housing associations and local authorities, health and education providers, especially universities, and infrastructure owners, public and private, who are perfectly positioned to create digitally enabled assets.

BIM in the Project Life Cycle: RIBA STAGES

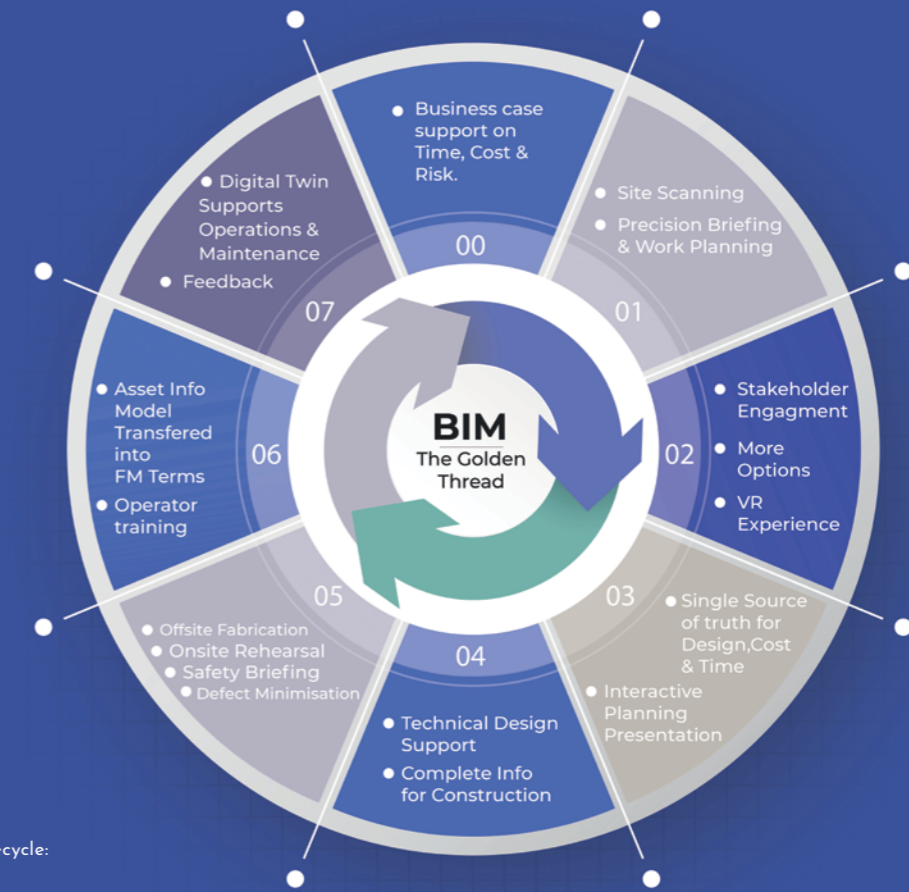


FIGURE 02
BIM in the Project Lifecycle:
RIBA Workstages

Investments & Benefits

Clients who want to employ digital methods on their projects need to invest in some areas if they want to realise benefits beyond those that accrue to their design and construction teams using BIM for themselves. The initial investment will be in spending time to become aware of the potential for their business and forming a strategy to take up the relevant parts on offer (see Module 2). The client's office will need to be equipped to be able to work with digital information (see Module 3). The next step is to set up a project formally to use BIM, the subject of Module 4. Legal instructions must be added to appointments and contracts. A service called a 'Common Data Environment', supported by a server which holds the shared information, will need to be purchased and managed. The pattern of benefit through the lifecycle of an asset can look like this, using the RIBA Plan of Work stages (see Figure 02):

RIBA STAGES 1-3: PREPARATION AND DESIGN

INVESTMENTS Consultancy to set up the client side: awareness, strategy-making, formalising the team's instructions, setting up the Common Data Environment (CDE), enabling the office to work digitally. Consultants' cost will be front-loaded as they create the digital model, bringing cash flow forward.

BENEFITS INCLUDE Rapid site survey; enhanced study of options; use of any standard design elements employed; enabled use of offsite construction; better engagement of stakeholders in reviewing proposals, including use of Virtual Reality; support to the planning process and funding; better design coordination and more predictable outcomes through simulation; general increase in speed and certainty.

RIBA STAGES 4-6: TECHNICAL DESIGN, CONSTRUCTION AND HANDOVER

INVESTMENTS largely made earlier, but continued service from the CDE. Facility Management systems may need upgrading for Stage 6.

BENEFITS INCLUDE reduced risk to all parties leading to better tender prices; reduced consultant costs for production information; better change management to avoid loss of value; few requests for additional information or opportunities to claim; potential for fast build, zero defects and no 'performance gap'; as-built information from scanning; O&M information ready to load into client's Computer Aided Facility Management (CAFM) system and managers trained before handover on the virtual building.

RIBA STAGE 7: IN USE

INVESTMENTS the CAFM system, and potentially a continuing Common Data Environment, are needed throughout the life cycle, with information updated whenever a change is made.

BENEFITS INCLUDE Operation optimised, with likely reduction in energy use and maintenance costs; maintenance activity planning optimised; workplace planning and space management supported for occupant performance enhancement; efficiencies in safety management, remodelling and end of life; structured feedback for future projects. There is also potential for integration with digital building control systems.

MODULE 02.

STRATEGY MAKING

Once a client has become aware of the scope of digital methods it is possible to identify the most relevant benefits for the business or service. This is a high-level exercise and needs the participation of top management at the client organisation, including the identified client leadership for any project which may be imminent. Key advisers must be in place, with BIM skills, to facilitate the process.

Firstly, the business model of the client organisation needs to be understood. What business is the client in and what factors create advantage and disadvantage for them? What constraints are they under and what obligations do they feel bound by? The economic, social and environmental context needs to be spelled out. This clarifies how built assets enable client performance and also create burdens. The nature of the client's business will give perspective on what benefits are most relevant from digital working.

Benefits vary for different client types

For example, is the client in a sector where construction projects are frequent, or even the core activity, and where assets are retained, used or managed? This client type will see benefits from almost all the possibilities and the issue will be to map a feasible road into deploying digital strategies. If the client is an occasional developer, but will live with the asset, the life-cycle advantages may still justify deep involvement with digital working. If the business model is to develop and to sell on completion, the benefits over a life cycle will depend on the aftermarket: do buyers want asset data to assist in their management of the space? Project-related benefits

will otherwise dominate the strategy. The commercial development model runs major risks in the early stages of projects: until planning approval is gained and the scheme can be financed and marketed, the priority is to minimise costs. Digital methods may well assist in winning permission, but these may fall short of the full use of BIM. Full deployment could follow once these risks have been reduced. For infrastructure clients, projects will almost always be additions to, or alterations of, existing assets. The ability to capture the existing asset into a digital model and to provide a data-driven asset operation will be convincing. The asset is the core of such businesses.

Making a roadmap

Strategy making can then move onto making the roadmap into digital working. The questions which should be addressed include the following. Is the best approach to develop client capabilities before launching a project, or must learning go on during real-time on a live project? What needs to be done to lift the client office into sufficient maturity in digital working (see module 3)? If a programme of work lies ahead, should the procurement of consultancy and construction work be reconsidered to optimise the chances of success (see module 5)? Should the brief-making process be changed to include stakeholder information requirements and ensure that all client decision-points are fully supported with required information (see module 6)?

Should the facility management capability of the client be involved in brief-making for operation and maintenance, in which case is this to be in-house or outsourced (see module 7)? Could the business use standardised briefing for some elements, like student rooms, treatment spaces, retail layouts or preferred products? If so these can become digital standards for easy re-use (see module 8).

The client may just decide to progress gradually, in real time on a project. This is fine and can be done by taking only the first four steps before starting: Awareness, Strategy Making, Equipping the Office and Formalisation. Other steps may indeed be considered unnecessary by this client.

Return on investment

The strategy-making sessions can usefully include a viability exercise to identify the return on investment from the benefits of digital working. The outline given in Module 1 can be worked up into detail, identifying cost and benefits specific to the client. This will support decisions on how far to go and how fast. The non-financial benefits, however, are considerable, but variable by type of client. For example, is speed of completion important? BIM-enabled offsite construction is the most powerful way to deliver speed. Even conventional design and construction will be quickened by digital working with its technological assistance and better decision support. Whole-life performance benefits will

also go beyond financial savings into enhanced occupier performance and reduced environmental impact. This is why the strategy session needs to be a high-level matter for the client, tapping into fundamental client goals.

If an immediate project is the context, it may be a sensible tactic to roll the digital strategy session into the opening stage of the project brief-making. This will avoid repetition of discussions and enable the brief-making to progress in the context of an agreed digital strategy. Module 6 sets out the way that the defining of information requirements relates to conventional brief-making steps.



MODULE 03.

EQUIPPING THE CLIENT OFFICE

A client that wishes to engage actively with BIM needs to equip its office with skills and systems to do so. That said, the amount of investment will vary with the strategy that the client has adopted (see Module 2). The passive client, unengaged with the supply team's use of BIM, would not need new skills or systems. The team will derive analogue

reports and presentations from their BIM work and the client will take decisions as usual and receive Operation and Maintenance manuals on paper, in binders, as occurred before BIM. We identify below several key steps into BIM-active clientship and their associated investment. This takes the form of a base specification plus potential upgrades.

BASE SPECIFICATION

this enables the client to have BIM used on their project in a controlled manner, principally to enable good coordination between parties and a flow of quality information to meet project needs. The client should identify a BIM Champion in the office, someone with enthusiasm for the concept and who reports to a director who can speak to the board for whatever is needed to achieve desired outcomes. The next step is to work with lawyers to prepare a BIM Protocol to go with all appointments and contracts, as described in Module 4. The base level content for this is to specify the technical standards to be used for information exchange. A Common Data Environment is set up and responsibilities are allocated to all appointees to deliver required inputs at the programmed dates for information exchanges. Whilst team members are expected to deliver complete and accurate information, client checking can pay for itself by catching errors and omissions. The client office may need training to run one of the model reader applications, such as Navisworks or Solibri. Normal office technology can handle this level of work.

TEAM FORMATION UPGRADE

Module 5 covers the logic and content of taking a different approach to the formation of the design and construction team when BIM is to be used. Its an optional extra to consider.

DECISION-SUPPORT UPGRADE

Module 6 introduces the option of asking for information from the model at each

decision point which is specifically there to enable the client and stakeholders to take clear and timely decisions. The organisation's purpose in undertaking the project needs to be set out as questions from stakeholders to be answered at each stage. These requirements are added to those already in the Protocol and work with the client, user and other stakeholders may be required to capture all the decision support needed. In addition to the traditional outputs of drawings and reports, much of the material requested can be presented interactively and the client may choose to be able to display the material to their stakeholders in one of the multi-screen or immersive methods, such as virtual reality (see Figure 03).

WHOLE-LIFE UPGRADE

Where the client will own or occupy the facility, the upgrade is to ask for full Operation and Maintenance information in digital format. This is set out in Module 7. The investment for the client will be to engage their facility management team at the briefmaking stage, to define what information they need to operate and look after all maintainable items. This defines the content of the as-built information model which the team will hand over alongside the actual facility. These asset information requirements will also join the Protocol and be checked at each information exchange as they grow in completeness. The 'Soft Landings' concept may be added to this upgrade also, adding the Facility Management brief to design and retaining contractors and designers through a shakedown period

FIGURE 03
FULmax BIM CAVE, a virtual reality experience for groups.



after handover to ensure performance is delivered. Increasingly, such clients will be interested in adding so-called Smart abilities to the facility, to sense conditions and control systems using artificial intelligence. These tools are powerful performance improvers for owner-occupiers and can be accessed via the asset model.

MULTI-PROJECT UPGRADES

Clients who build regularly and have a degree of standardisation in requirements can use BIM to simplify briefing and communication. Module 8 describes the virtue of investing in models of repeated elements, from individual rooms to complete buildings. These can be with or without construction detail, to instruct suppliers. Preferred product data can also be held in a library. Feedback analytics from completed projects, to inform and improve subsequent ones, are worthwhile investments enabled by BIM. The classification system embedded in BIM enables accurate benchmarking between projects down to element level. Data can be analysed to improve product and practice.

STEP BY STEP

Clients may choose to start simply and add selected upgrades in any order when their confidence or needs increase. Mid-project upgrades are less economical than those asked-for at the start, but successive projects can build on experience.

MODULE 04.

FORMALISING THE USE OF DIGITAL WORKING

Conventional project launching includes a decision on the 'procurement path': how will the project buy professional and construction services? Choices range from contractor-led design-build, through traditional working to client-led construction management. 'Traditional' is where the client appoints professional consultants for design, cost and project management, then seeks a contractor to build the design. Design-build puts the team under contractor leadership, either from the start or at some point during the project. Construction management is when the client hires all suppliers directly,

retaining control and risk (see module 5). Agreements for those retained are formalisations of the obligations of both sides. When digital working methods are employed, the standard forms of appointment and contract need to be augmented to take into account changes in traditional processes and obligations. Properly managed BIM requires that all parties involved have clarity as to their rights and duties, particularly regarding the digital models. Unless these rights and duties are contractually binding there may be poor coordination, unexpected risks and avoidable disputes.

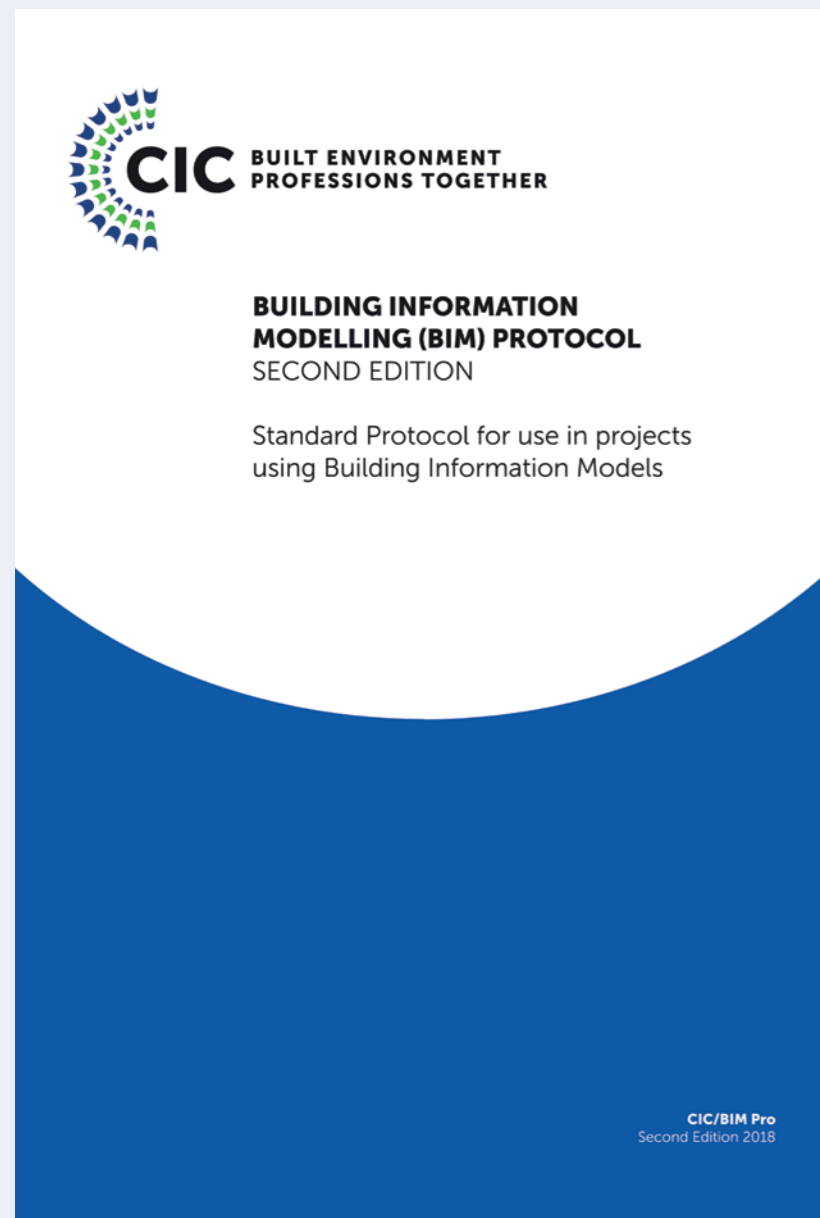


FIGURE 04
The Construction Industry Council's BIM Protocol, second edition, 2018.

Appendices to the Protocol

The first two appendices to the CIC Protocol set up the plan of work for all parties and the information particulars: that which is to be delivered at each stage (the Responsibility Matrix) and the plan to achieve this (the BIM Execution Plan). The client should review the contents of these appendices at each stage as understanding of the project deepens. There is also an option in the Protocol for the client to have a full policy for data security, led by a

security manager. If used, these instructions would form a third appendix. A format for security-minded BIM practice exists⁰⁴. The client may decide to initiate BIM usage by defining only the information exchange standards in detail. If they choose to define their decision support needs in full (see Module 6) or their operation and maintenance information needs (see Module 7), these requirements would also form part of the first two appendices.

Clarity for All Participants

The Protocol provides clarity to all parties on their rights to use and obligations over the shared digital models and the intellectual property they contain. This clarity is vital to ensure good practice and to avoid differing expectations. The client's lawyers will need to be the ones completing the drafting of these additions to the contract and it is important that they are well versed in BIM and its principles so that they do not undermine the effectiveness of the process by incorrect terms or incomplete documentation.

The protocol becomes part of the building contract and of all subcontracts. The post-contract digital model develops by progressively substituting actual proposed

products and specialist contractors' detailed designs for the place-holders included in the consultants' model. The final version is the as-built form owned by the client as a record and potentially for operational use.

This formalisation of the BIM process should be an established part of the selection and briefing of all the consultants and the contractor for any BIM-enabled contract. Good planning of the work and clear allocation of responsibilities is at the heart of effective project management. The advent of digital working methods brings a new rigour to the setting up of projects which will work to the client's advantage throughout their progress.

The BIM Protocol

The contractual vehicle for adding these instructions to most contracts⁰² is called a BIM Protocol. There is a standard form for this⁰³ (see Figure 04) though it can be modified or bespoke. The Protocol usually consists of a main section which defines terms and principles, followed by appendices carrying project-specific processes and details. The employer/client is obligated to complete the Protocol and to incorporate it in each agreement made with their team members. They should also comply with the project standards, methods and procedures detailed.

The client is asked to appoint an Information Manager (IM) to support good practice across the team and this role will be a source of advice on what the client should ask for. The role is ideally played by the

lead consultant during the design stages, then passed to the contractor when they take the lead. An outside consultant can also be used where the lead consultant lacks capacity. The client may also wish to have an in-house information manager. The IM recommends and sets up a Common Data Environment (CDE) which is an electronic repository that holds all shared information, controlling access, progress and changes. The IM also recommends the information exchange standards to be used and monitors information quality. These standards structure the information to allow all parties, including the computer, to read and share it. As each designing party produces their own information models, the lead consultant coordinates them, enabling the work to be fit to be shared with the client.

⁰² Whilst JCT 2016 contracts require a Protocol to be attached, the equivalent to the contents of a Protocol are incorporated into clauses in the NEC4 forms of contract.

⁰³ The model protocol is produced by the Construction Industry Council and known as the CIC Protocol. (www.cic.org.uk/admin/resources/bim-protocol2nd-edition-1.pdf)

⁰⁴ Security-minded BIM: PAS 1192-5. (<http://shop.bsigroup.com/pas1192-5>)

MODULE 05.

REVIEWING TEAM FORMATION

Limitations of conventional arrangements

Level 2 BIM is designed to work with conventional arrangements for forming teams, contracting and insuring projects. However, some of the potential for improved performance depends on good collaboration across a team whose members are familiar with the selected way of working and come together from the start. This isn't normally the result of conventional ways of team formation. The convention is to start by appointing an architect and cost consultant to study the feasibility of the project and write the brief. Project managers and engineering consultants are typically added once the job reaches Stage 2. These consultants are usually all selected separately by

competition between shortlisted firms to find the 'best of breed'. The main contractor is not involved until the design is well developed and is chosen by price competition based on the drawings and specifications prepared, with the cost consultant predicting the price which should win the work. The contractor prices keenly to win but often relies for profit on extras arising from the inevitable errors in the information they will be given and on client mind-changes after contract. They also regularly seek to substitute specified products and materials to reduce their costs, both to stay within budget and to enhance profit. Maintaining whole-life client value can be challenging in this approach.

Better Practice

None of these behaviours is ideal for working with BIM. Speed of working is not easy to get when the team is a scratch one that neither knows each other nor the ways of working which the lead consultant prefers. Levels of competence in BIM may be very variable and firms may use incompatible software. It is much better to form the consultant team by recommendation from the lead consultant, or to select from a framework, a pre-qualified panel of known ability which should have been working to improve working methods collectively. Contractors can also be selected from such a framework of proven capability and should ideally join the team as a consultant contractor as early as possible, or be put

in the lead from Stage 2, selecting their choice of consultants. Either route allows the contractor's expertise in buildability and information management to come to bear. It is particularly important if offsite fabrication of all or part of the building is an identified possibility. In this case the key manufacturing specialists will also need to join in early. None of this allows for tendering on a completed design; indeed, it follows the prevalent manufacturing model of choosing the supply chain on ability and compatibility and setting product performance and cost targets to be achieved. The team can be incentivised to hit the client's budget by taking a share of any savings and/or paying for any overshoot.



FIGURE 06
Insurance-Backed Alliancing pilot project, Dudley College Advance 2 building, 2017. Photos IPInitiatives.



FIGURE 05
Insurance-Backed Alliancing pilot project, Dudley College Advance 2 building, 2017. Photos IPInitiatives.

Collaborative Contracts

The style of thinking enabled by BIM is to control the very real risks of construction by good management rather than by simply allocating risk to suppliers regardless of their ability to control or bear it. As information in the project will be 'perfect': complete, unambiguous and verified, there should be far less risk anyway. Construction sequences can be rehearsed until perfected too, speeding the work and making it far safer. Defects can be eliminated by good information and by digital scanning of work in progress before it is closed in to compare it automatically with the design model.

This collaborative approach suggests that use of the conventional forms of contract should be re-considered. Traditional approaches involve a transactional relationship between client and contractor, with a form of contract which some say is designed to manage failure rather than to facilitate success. Adversarial relationships emerge from the way issues are handled, souring collaboration. The risk-managed approach can be based on a collaborative form of contract, ideally between parties who have a long-term relationship.

The best motivator of satisfactory service is the promise of more work to follow. Collaborative forms of contract from several sources are being used by Government departments to facilitate good outcomes: The Ministry of Justice uses a partnering style contract. There are also government-backed pilot projects in progress of an Insurance-Backed Alliancing approach that guarantees no significant loss to the client or team, with the upside of shared savings made⁰⁵ (see figure 05, 06). Collaborative working can be taken to its ultimate in what is called in the USA 'Integrated Project Delivery', where client, consultants and key constructors work in alliance without the strictures created by risk transfer from the client. Terminal 5 at Heathrow was built that way, pioneering the use of BIM and arriving on time and budget. Many other infrastructure clients work this way now and there is increasing interest across the industry.

Where the building will be occupied by the client organisation, the operational team for the building should also be involved early, rather than at handover only. For more on that topic, see module 7.

⁰⁵ www.ipinitiatives.co.uk

MODULE 06.

DECISION SUPPORT REQUIREMENTS

The client for a digital-working project can instruct the team to provide specific and relevant information to support decision points throughout the project. In conventional, non-digital practice, the client expects to receive submissions at each stage of the project in the form of drawings and written reports showing how the evolving design, cost and timescale answers the terms of the brief, with progressively greater accuracy and detail until the project is approved for construction. With digital methods, there is a need to be very specific about the degree of definition

to be achieved at each decision point, plus the potential for a more considered brief to ensure that stakeholder decisions can be made promptly and fully, with little risk of reconsideration. One weakness of analogue working has been that decisions might be delayed for lack of sufficient content in a submission to satisfy all stakeholders, or that decisions might be reversed or modified later for lack of clarity about the proposals in some stakeholder's minds. With digital working, there is a risk that too much information will be provided. Clear direction is essential to avoid wasted effort.

Requirements Capture

The client's requirements are, of course, first defined in the briefing process. Stage Zero, before the project is launched, needs a strategic brief to make the business case for the project. Stage One should develop the brief with the appointed design team into a full outline to enable design to begin. Stage Two includes both the concept design and the final brief which should reflect what is chosen to happen in the concept. The client's programme will define several decision points at which progress will be measured, often two or more within Stage Two and a further two or more within Stage Three. These decision points will involve not just the paying client, but other stakeholders inside and outside the client body, such as users, funders, planners, regulators, marketing people, and committees within the client structure. The needs of each stakeholder have to be defined and the right way to inform them must be considered. The digital brief should set out exactly what information should come out from the team at each decision point to meet the requirements of each contributor to the client decision to progress.

covers all aspects, moving from the client's goals through to the specific content which the building must provide to meet them. A fifth column is added for digital working, listing the kinds of information output that are needed to support decisions. Under 'Function' comes information that supports the project decisions that the client will take and that will enable asset operation and management. Under 'Form', it is the form of the information that matters: the technical standards to be used in the project to enable everyone to interact on the same basis. Also, how should this information be presented: performance simulations, static perspectives, walk-throughs, virtual reality, cash-flow charts? Under 'Timing', it is the planned programme of information exchanges, decision points and submission for regulatory approval. Under 'Economy', the level of definition of the information should be stated to prevent wasted effort at each decision point.

The power of digital models to show how proposals will work, look and feel is the greatest advance over static drawings and reports. Simulations and virtual reality experiences bring ideas to life and prevent mistaken assumptions taking hold. Changes made early are value-adding. Those made late destroy value.

The table below (see Figure 07) sets out a briefing matrix, based on one of the long-standing briefing techniques called Problem Seeking. The four-by-four matrix

FIGURE 07
Briefmaking for Digital Working. C. Richard Saxon, after 'Problem Seeking' by Pena et al. 5th Edition 2012, John Wiley.

Briefmaking for Digital Working

	GOALS	FACTS	RULES	NEEDS	INFORMATION
FUNCTION					i) Decision Support ii) Asset Particulars
FORM					i) Exchange Standards ii) Presentation Formats
TIME					Exchange Points in the Programme
ECONOMY					i) Level of Definition at Exchange ii) Change Controls

The Design Brief



Mapping Stakeholder Information Needs

It may well prove productive for the client to map all stakeholder activities and their intersecting paths in approving progress of the project. This will inform the team better about the timing and content of decision support information for each stakeholder. As an extreme example, the Ministry of

Justice held a workshop to plot the path of all internal decision-taking in their process. This had never been understood fully before and it clarified what was needed to ensure timely decisions that would stick. Projects now move faster and with little back-tracking.

Instructions to the Team

Required decision support information should be defined at RIBA Stage Two as part of the developed brief, setting out the team's tasks and the BIM Execution Plan to deliver. There should also be instructions on the handling of any changes after sign-off. Changes do happen, even if the client does not initiate any. Difficulties in getting

products or materials, or permissions, can drive change. Contractors can suggest changes to save money, for the client and themselves. Lost time may need to be recovered. How these changes will be handled needs to be laid out, with the basis for approvals and updating of the project information model.

MODULE 07.

OPERATION & MAINTENANCE REQUIREMENTS

The advantages of digital working to the operational life cycle of a facility are the largest of the paybacks available. Compared to analogue methods, digital O&M information management is transformative. Conventionally, contractors are asked to provide O&M information at the handover of the asset, consisting of as-built drawings and binders containing all the information necessary to understand how to operate and maintain the

facility and its equipment. This often takes months and even years to finalise, with the facility manager filling a good-sized room with the information, and with no guarantee that it is all correct or complete. Managers populate computer aided facility management systems (CAFM) by laboriously loading data from the files and from re-surveying the building. Again, months can elapse to do this, at high cost.

The Digital Estate

Good digital practice should follow similar lines to the scenario described here, where the project happens to be a building. It involves asking the contractor to provide an as-built version of the project information model. This contains not just the building's geometry, but all relevant data to enable maintainable items to be looked after. It is transferable into the CAFM system automatically if the right information standards are asked for and is self-validating for completeness. The contractor would build up the database on the back of the consultant's model as each product is selected, gathering manufacturers' data via templates which ensure that it is compatible with requirements. This process gives the building owner a quick and clean start and saves the need for a file room. As an example of potential efficiencies, when maintenance tasks are needed information to carry out the work can be found quickly, and the location of any problem device pinpointed in the model. Augmented reality tools can be used to find the item needing attention, behind a ceiling or wall finish. Multiple engineer visits needed in analogue working can become a single one, bring needed parts to the precise location to fix the problem. Tablets and smart phones bring the data to the worksite and capture completed changes into the asset model.

This cost-saving and performance-enhancing working method needs the client to specify what information they will need at the handover point to operate and maintain the facility, plus the format for the information. The provision of this output is added to the BIM Protocol Appendices and its delivery should be included in the contractor's BIM Execution Plan.

It is currently unusual for clients to involve facility managers at the briefing stage of a project, but the payback is substantial when this is done for owner-occupied buildings. Government BIM practice calls this 'Soft Landings' as it provides occupiers with a gentle transition as they move into the new facility. In this scenario, the FM consultant sets out the information required for safe and effective operation and maintenance, then checks at each work stage that necessary progress is being made on the content. At handover, the asset model is received, and the building staff trained using simulations on the model before touching the real thing. The contractor and relevant specialists remain on call during 'sea trials' as the building is put to use. Any glitches can be addressed on the spot. The Soft Landings process concludes with an in-use evaluation of the facility after three years in the service of the user, comparing achieved performance with that required in the original business case for the building and capturing learning. The government uses the Soft Landings process both to achieve good building performance in terms of energy and maintenance costs but also to track how effectively the facility supports the occupier organisation. The long-term benefit of this 'golden thread' of asset information is highlighted in Dame Judith Hackitt's report after the Grenfell Tower disaster.

The cost of operating the digital information management system: maintaining a Common Data Environment for all users to access data, updating the asset model with any changes made and running the CAFM application, is very modest compared to the payback.

Integration of information in a common data environment

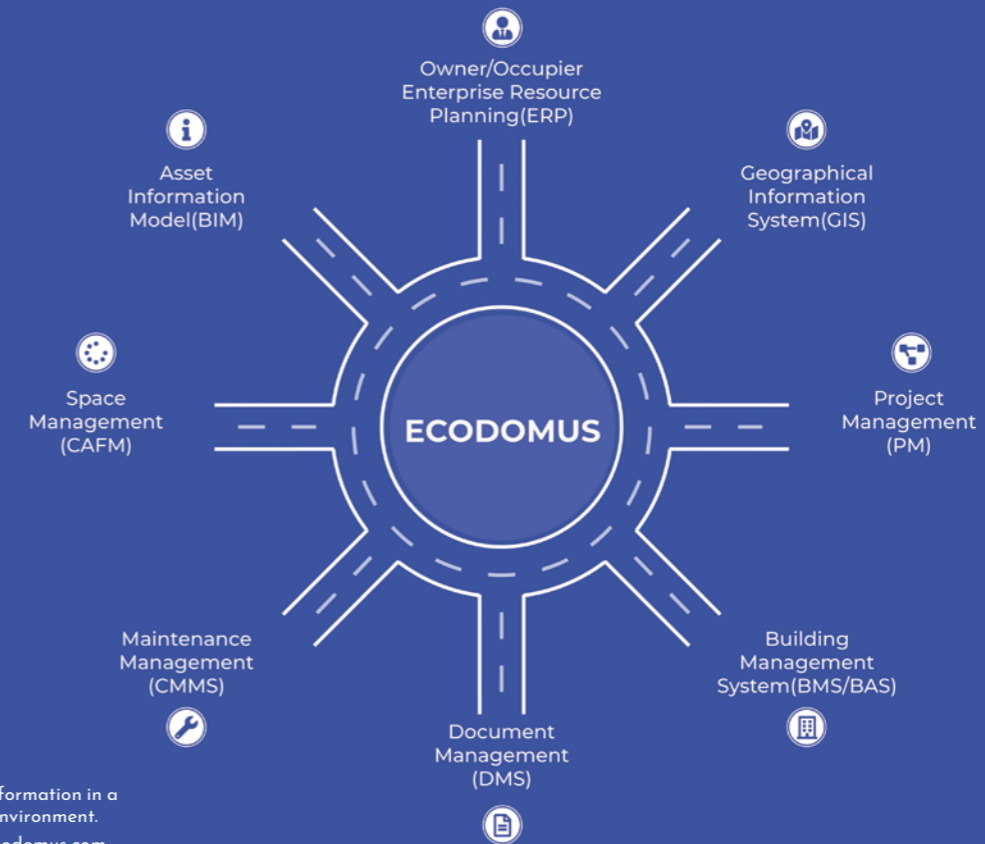


FIGURE 08
Integration of Information in a Common Data Environment.
Example from ecodomus.com

Smart & Cognitive Buildings

The recent arrival of so-called Smart Building technology supercharges the case for digital asset information management. Now that cheap sensors and controls can report on the state of all systems and the use being made of all spaces, there can be a step-change in facility utilisation and efficiency. Workplace management systems can allocate spaces to staff based on their daily need, maximising the number who can be supported by the building and avoiding service to unused space. System problems can be sensed coming, allowing pre-emptive maintenance, avoiding breakdowns and prolonging equipment life. Smart technology overlays the digital asset model; it is not

a substitute. A suitable Common Data Environment (see Figure 08) can support information flows from all sources, including occupier business systems, and provide powerful support to a building owner and occupier to optimise performance from the facility and comfort and wellbeing for its occupants. The Asset Information Model can be used as the access route to flowing information from all systems and spaces.

Once artificial intelligence is added to the analytics in the smart system, the building becomes 'cognitive', able to learn, co-operate with occupants and largely automate building operation.

MODULE 08.

SETTING STANDARDS

34

For clients with estates to manage or a regular programme of development, the ability to store and recall preferred briefs, designs or products is one of the advantages of digital working. Such clients have often tried to use standard elements in their projects, but it has not been simple in analogue working to apply them. Recording all the properties of a preferred element by drawings and specifications is laborious and each application tends to drift into variation.

A virtue of BIM is that storing an element of design or brief is simple. The system recognises 'objects', be they pieces of equipment or layouts of spaces. All the relevant properties of the object can be stored: shape, materials, performance requirements or solutions. These stored objects can be held in a 'library' for retrieval and insertion into a new project or refurbishment.

Examples of stored standards range from Ministry of Justice courtroom briefs, through layouts of fixtures in John Lewis stores and room data for hospital plans to preferred light fittings for a developer's

office portfolio. The MoJ holds the brief for its range of court spaces as models without any construction content. The sightlines, layout and performance criteria are standard, so that proven patterns can be called for and re-used without error. Time is saved both in briefing and in checking proposals. Pocket Living also holds briefing models of its standard small flats (see Figure 09), so that it can be sure that the optimised arrangement is repeated precisely. Construction technologies can be varied to suit the project, but the interior spaces are set by importing them into the RIBA Stage 2 project design.

This approach makes simple the otherwise daunting business of ensuring that hospital briefs are understood and signals the way of the future. General hospitals can have 4000 rooms, each with room data which specifies layout, performance, equipment and finishes. These rooms have been re-created per project many times but can now be uploaded from the library in an error-free way. Continuous improvement in these standard briefs is always possible, with feedback from use suggesting how the standard can be updated.

35

Offsite Construction

As offsite construction advances so standard construction elements can be imported into designs. It is anticipated that significant advances will be made in this area in the next few years. Several developers of hotels and student accommodation are storing standard rooms and their construction in libraries as built modules. They can be ordered, with all their required parts, for delivery to site. Many designers apply proven standards from their own libraries, such as staircase layouts, lift shaft designs, floor and ceiling 'sandwiches', to speed the development of detail design. Contractors will import product objects from manufacturers when the product to be used is finally identified, bringing in all the data needed to maintain the product as well as to fit it into the

building. The manufacturing world makes apparently new products largely from combinations from a standard 'parts bin'. This reduces costs, increases reliability and speeds delivery of an updated product. The parts are held as digital objects; construction is heading this way also.

For clients, the creation of these model standards can be done either by asking the design team to extract and store an element already used, or by asking for an element to be modelled for re-use and put into a library. The client can hold the models in their own Common Data Environment or they can ask their retained consultant to do so. The rights to re-use designs will need to be covered in agreements with consultants.

Conclusion

These eight modules have covered the application of digital working by clients in increasing depth. It is possible for useful progress to be made by applying just the first four steps: becoming aware, making a strategy, equipping the office and formalising use. The remaining steps are worthwhile for clients with the need and opportunity to go further. Each has a business case and a return-on-investment profile. The emergent addition of digital sensors, analytics and actuators to buildings will reinforce the value of having an asset model to automate as a 'digital twin'. Bringing 'smart' and 'cognitive' technology to bear in an integrated way is beyond the scope of this introduction to digital working but will soon become a normal consideration.

FIGURE 09
Standard briefing model for a one-bedroom flat. All relevant data is embedded. Deploy: BIM Strategies and Skelly and Couch for Pocket Living.

