As the deadline for the UK Government’s mandate gets closer, the take-up of BIM on projects and programmes is accelerating. Simon Rawlinson and Bram Mommers of Arcadis examine how clients can get the best out of BIM through effective procurement.

INTRODUCTION

The adoption of BIM promises many benefits to far-sighted clients and their supply chains. 3D visualisation promotes better-informed decision making, better coordination helps to de-risk construction and – most important of all – BIM creates the potential to make use of comprehensive, valuable data throughout the lifetime of an asset.

All of these benefits rely on the ability of project teams to create, share and re-purpose valuable digital data. For this process to be successful, project teams need to be directed to adopt common standards and model formats.

However not all clients are securing these benefits. BIM will only deliver them if the right data is acquired in the right formats at the right time on a project. Asking for ‘Level 2 BIM’ clearly does not provide enough of a brief for this to happen. Regrettably some clients and advisors are still procuring BIM on this basis. This situation can be blamed on a lack of experience and expertise, which when combined with tight project programmes can mean that neither clients nor their advisors have the vision, time or capability to procure BIM properly. Furthermore, as skills and capability develop within the supply chain, the risk is that clients will become a significant limiting factor on the impact of BIM.

Used out-of-the-box, BIM software is a significantly improved version of ‘electronic paper’ – providing better visualisation and coordination of the design. Even these improvements provide big benefits, and project teams experimenting with ‘lonely BIM’ do not need to invest heavily in information exchange processes. However, the coordinated application of BIM on projects and programmes based on Level 2 standards has the potential to be transformational. This is because it enables clients and their teams to break long-established, inefficient habits associated with design information production, which include:

- Fragmented, uncoordinated information production based on large numbers of separate drawing files;
- Separation of the geometry of the design from the technical data associated with the design;
- Inconsistent adoption of standards associated with file naming, drawing styles and so on.

Whilst designers and contractors are increasingly able to exploit the benefits of model based design through model coordination and automated scheduling, current practice still includes a lot of duplicate activities. Production of drawings from a model for contract purposes is a good example of how commercial practice has not yet caught-up with the potential for enhanced Information Management provided by BIM.

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KEY ELEMENTS OF A BIM PROCUREMENT PROCESS

There are four key stages in the implementation of a plan for the procurement of BIM for an organisation. These stages progress from identifying the uses of the BIM to putting in place the infrastructure to deliver the BIM – such as modelling standards and contracts. Paradoxically, because investment has been made in the UK in developing processes and standards, client understanding of BIM uses and related information requirements are less well developed.

The key stages are:

- Identifying and prioritising a client’s key uses of BIM
- Defining and developing the processes that support each BIM use
- Defining the information exchanges for each process
- Implementing BIM systems and processes.

Ultimately all of the elements of the procurement plan will be communicated to the project team using the Employer’s Information Requirements and a BIM Execution Plan.

1. PRIORITISING KEY USES OF BIM

A key success factor in BIM is that planning of BIM uses should always be undertaken ‘with the end in mind’. Early planning means that all members of the Project Team will be clear about how the model is going to be used which enables information to be created at the best time, avoiding unnecessary re-processing or re-keying of information. A good example of this is the early adoption of a data classification that aligns with the employer’s asset management system – so that even though none of the model objects are populated with operational data until later, the objects can be readily linked-up to existing systems. Other examples of uses for BIM on a project include project sequencing, health and safety, visualisation and so on.

The ability to deliver planned uses on a project depends on the capability of the team and the maturity of the client’s systems. The use of models as the basis for cost estimation relies for example on the project team to be able to provide a comprehensive design to an agreed level of detail as well as having a cost consultant with the software tools and systems needed to generate NRM-compliant outputs. By assessing the effort required to deliver a model output as well as the benefit gained, clients can make an informed decision as to what the best uses of the model are.

Factors that get in the way of effective planning of the uses of a model include:

- Fragmented operations within the client body – particularly the split between asset creation, asset management and facilities management
- Short-term planning on projects – such as the appointment of project teams on a stage-by-stage basis
- Inability to define the end-user – often experienced in commercial and leisure projects where the tenant/operator is not involved at the outset of the project

Having clarity over constraints that will affect the ability of a client to make full use of BIM is a valuable part of the BIM planning process.

2. DEVELOPING THE PROCESSES THAT DELIVER THE BIM USES

BIM uses require processes and exchanges of information between different members of the project team. The processes used to produce information for visualisation of the design are quite different to those used to prepare models for use in a tender, but the models, objects and standards used are fundamentally the same. In effect, each use needs a ‘recipe’ which sets out the required outputs, the steps in the process and the data that needs to be provided and processed by different parties.
The key components of a BIM recipe are:

- **The output** - often defined in the UK by a ‘Plain Language Question’, such as ‘Will the design meet the brief?’ Outputs typically support decisions at the end of project stages before a client instruction is given to proceed to construction or take possession.

- **The processes** - the combination of design, analysis and model development activities that are needed to deliver the answer. The complexity comes from the sequence of team activities and how these affect the flow of information. Some of the processes will be developed by the client, but most will be undertaken by the project team and will become increasingly standardised as BIM adoption increases.

- **Data inputs and outputs** – the actual data that is needed to complete the task. The importance of defining the data requirement is to ensure that only the information needed to complete each use is included in the model. This tackles the risk of ‘infoboccy’ – where too much information is included in models whilst also making sure that the data foundations are in place for other priority uses.

Sufficient detail of the outline of these processes is needed in the Employer’s Information Requirements so that consultants and contractors can develop an outline response in their initial BIM Execution Plans. Lack of clarity at this stage could result in an incomplete BIM submission.

Employers with a large enough project portfolio could benefit from developing standard recipes focused on supporting their business process. However, detailed aspects of the processes will have to be developed by the project team – which encourages early appointment of delivery teams, programme-based procurement and effective collaborative working.

### 3. DOCUMENTING THE INFORMATION EXCHANGES

Documenting the information exchanges involves a process of defining the content of the ‘data drops’ required at different project stages. Some data drops will be internal – such as the substitution of detailed design elements provided by a sub-contractor. Others, such as the issue of design or as-constructed information at the end of a project stage, will be a formal contract deliverable.

With the publication of the Digital Plan of Work and accompanying Design Responsibility Matrices, it is now much easier to define these information requirements for objects in the model:

- The Plan of Work uses well-defined project stages so that all parties are working to deliver information on a consistent basis
- The amount of geometric detail and asset information is clearly defined – enabling standard objects to be pre-populated with the right amount of information
- Common classifications assure that similar items of work are given the same names – enabling consistent management of data from the model
- Models can be validated for completeness in accordance with the client’s requirements.

Defining information requirements is the most difficult aspect of the BIM process as it requires employers and project teams to really understand their processes and how data is used and re-used. For clients with a large portfolio of work, the benefits of investing in streamlined, automated information exchanges could be significant. However, even for occasional clients, the ability to define information requirements for a limited number of uses using the Digital Plan of Work is an opportunity to improve project performance.

### 4. DEVELOPING BIM PROCESSES

BIM processes are the infrastructure on which a successful implementation is based. They include planning tools, contracts, data exchange processes and quality control. In the UK, the development of BIM Processes has been concerned with ensuring that all of the building blocks of BIM Level 2 are put in place. These cover process and many aspects of project culture – giving clients the opportunity to build on an increasingly consistent way of working which will become even more effective as project teams become more experienced. The key components of the Level 2 suite are as follows:

- **PAS 1192:3**, which defines the information management requirements associated with the operation of assets. It is an essential document as it enables employers to define their lifetime Asset Information and Operational Information Requirements. It embodies the principle of planning BIM with the final outcome in mind.
- **PAS 1192:2** defines information management for capital delivery. In common with PAS 1192:3 it defines the work stages to be adopted on a project, the use of the Common Data Environment and the format of project outputs – including structured data. PAS 1192:2 also defines the content of the Employer’s Information Requirements and the BIM Execution Plan – the key tools for defining the client’s BIM uses and standards and for describing the Project Team’s detailed response.
- **BS 1192:4** is the standard for digital information exchange using the standard excel-base format COBie. Employers only need COBie because it is the best standard to use to enable information to be transferred from one software platform to another. For example, COBie will be a key solution in getting asset data out of BIM into a CAFM system.
A further cause of under-delivery on BIM is that expectations with respect to the use and impact of BIM on a project can outstrip the effort put in by the team to develop the processes. Key causes of a shortfall in preparation include:

- **The ability of the client to take advantage of BIM capability** – e.g. does the client have well-defined asset and facilities management process and systems;
- **The willingness of the client to invest in BIM** – many clients continue to limit their investment in BIM implementation on projects to visualisation and design coordination;
- **Limitations of the procurement process such as the appointment of teams on a stage by stage basis** – creating the opportunity to delay the BIM implementation decision and also limiting the extent to which ‘end in mind’ uses are considered;
- **Lack of input from an end user** – common for commercial development where tenants and operators will not be signed-up at the start of a project.

Other factors that lead to under-delivery include:

- **Model management** – lack of basic team discipline with respect to the structure and content of models which make information exchange more difficult;
- **Quality control** – production of incomplete models with poor quality data which undermines a team’s confidence in their use. This is especially important if models are being used for contractor procurement;
- **Inefficient processes** – inconsistent modelling practice that results in duplication of work in the project team or loss of attribute data during information exchange;
- **Infobesity** – capture of data for the sake of it, resulting in models that are too large to be used efficiently.

**WHY BIM IMPLEMENTATION CAN FAIL TO DELIVER ON ITS PROMISE**

It is well known that BIM involves processes and ways of working as well as a set of technology tools. Accordingly, the transition for a client to a position where they can consistently buy data from the supply chain requires planning and investment. As the uses of BIM required by the employer become more complex and the information exchanges more sophisticated, then the need to invest in planning grows. Lack of planning is probably the main cause for BIM under-delivery – either through lack of clarity as to what the models are for, or lack of detailed planning to enable the implementation of a more ambitious information requirement and project process.
**BIM USES ARE SPECIFIC PURPOSES FOR BIM WHICH SHOULD BE IDENTIFIED AT THE EARLIEST STAGE OF A PROJECT. TECHNOLOGY AND PROCESSES ARE CURRENTLY AVAILABLE FOR ALL OF THESE USES TO BE APPLIED ON PROJECTS.**

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<th>Capture</th>
<th>Generate</th>
<th>Analyse</th>
<th>Co-ordination</th>
<th>Communicate</th>
<th>Realise</th>
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<tr>
<td>Collection of data and geometry to record the current status and condition of a facility – for instance, 3D laser scan</td>
<td>Prescribe</td>
<td>Co-finding and correcting spatial conflicts in different design models – for instance, clash detection</td>
<td>Visualise</td>
<td>Fabricate</td>
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<td>Quantify</td>
<td>Structured, model-based measurement of the components of a facility – for instance automated quantity take-off</td>
<td>Forecast</td>
<td>Providing a realistic, understandable image of the design – for instance, 3D “walk throughs”</td>
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<td>Monitor</td>
<td>Collection of data recording the performance of an asset and asset system – for instance, integrated BIM and BMS data</td>
<td>Transform</td>
<td>Reformattting data and information for use by other applications – for instance, COBie data exchange</td>
<td>Assemble</td>
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<td>Qualify</td>
<td>Collection and updating details of the condition and status of components of a facility – for instance, asset data held as object attributes</td>
<td>Validate</td>
<td>Confirming that technical solutions meet specification requirements – for instance, automated model-checking</td>
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**CRITICAL SUCCESS FACTORS FOR BIM ADOPTION**

BIM is an emerging way of working. Not all project teams have the skills to apply BIM and many of the processes that are used are still in development. There are a small number of critical steps that clients and their teams can take to increase the chances of a successful BIM implementation on their projects which include:

- **Strategic planning with the end in mind.** Planning with the use of the asset in mind is vital if a client is to secure the full life-cycle benefits of the model. Planning BIM data-use backwards from operation is the best way to ensure that the critical information is captured.

- **Being clear what the BIM is for.** Project teams need a clear plan to deliver the agreed uses of the model to avoid either under-delivery of functionality or over-delivery of data. In the public sector, this plan needs to be aligned with the mandated requirements of BIM Level 2 and public procurement.

- **Maximising engagement with models and data.** The more that the project team and the employer use the models directly, then the greater the appreciation of the value and potential of the model will be. With simple 3D viewers including 3D PDFs available, there are very few barriers to direct engagement with the model.

- **Embedding enthusiastic experts in the team.** BIM use is infectious and the presence of one or two highly capable users within a team can make a huge difference in the establishment of a pro-active BIM culture.

- **Only asking for data that will be used.** Project processes should be designed with the procurement process in mind. Early planning should help to avoid reprocessing – either for designers in revising concept models or contractors providing unnecessary object-based data.

- **Development of a realistic BIM implementation and investment plan –** setting aside enough time and resource to plan and configure the BIM uses and the information exchanges that sit behind them.

- **Detailed tactical planning –** including the definition of the content of information exchanges at project stages for all of the BIM uses identified by the client.

- **Development of a plan to use standards and common processes that benefit the client.** Specification of client-defined standards based on industry norms will enable clients to drive efficiencies into their own internal process. This may require business change within the client organisation but will result in longer-term efficiencies associated with project and asset management.

- **Rigorous definition and use of quality control processes and standards** to assure the completeness and consistency of model and data production.
CASE STUDY – DELIVERING BIM-ENABLED FACILITIES MANAGEMENT

The case study is based on a development of Student Residences by a University Client. The overall objective of the project was to deliver world-class facilities to the university that was defect-free at handover and could be demonstrated to meet exacting performance standards. The project was commissioned at a relatively early stage of the development of UK Government BIM Strategy, and although the objective was Level 2 compliance, the project did not benefit from the availability of all of the Level 2 standards such as PAS 1192:3, BS 1192:4 or the Digital Plan of Work. In addition to Level 2 compliance, the project demonstrates the use of BIM-derived data in support of the implementation and assurance of the Government Soft Landings approach to performance specification, handover and maintenance support.

The BIM implementation was driven from the outset by uses associated with FM. This required the information requirements associated with FM to be clearly defined, which required a focused series of client engagement workshops aimed at identifying all of the clients requirements associated with meeting FM and Asset management standards such as SFG20, which defines the planned preventative maintenance requirements for each asset. In the end, a standard set of up to 90 FM attributes were defined for all relevant assets. These ranged from locational attributes and specification details to information on key maintenance activities.

In addition to FM outputs, the project benefited from extensive use of visualisation during a design development process that involved extensive consultation. The contractor used the models to assure a defect-free handover.

The employer had an estate-wide FM management system in place and the BIM strategy was designed to ensure that the FM data could be readily transferred into the CAFM system using a COBie-enabled information exchange. Most of the data was held in a data model linked to a federated design model which features geometry and design and construction attribute information. A key modelling principle adopted by all members of the project team was to assure that usability of the models by limiting the amount of embedded attribute data.

At handover, the employer was provided with a fully populated CAFM model, including all planned preventative maintenance activities derived directly from the construction models together with an electronic O&M manual. Data from the BMS system was also used to validate performance of the buildings against standards set in the original BIM model.

The case study illustrates the importance of a strategic focus by the client on one or two BIM uses. In this case, the achievement of a Level 2 compliant coordinated model that could be used by multiple parties, and the delivery of FM information in a useable format. The employer invested in the agreement of a common dataset on the basis of which a BIM information exchange was developed. The success of the project within a constrained construction programme demonstrates that significant downstream BIM benefits can be secured by non-expert clients that have a clear commitment and vision to obtain specific project outcomes using BIM.