JONATHAN REEVES 'LOOKING UP'

BIM for building management

BPR Architects

PRACTICE
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TECHNOLOGY
Vectorworks Architect (PC)

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Rail, regeneration, education

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THE PRACTICE Based in West London, BPR's team of 16 architects works on a range of university, rail and regeneration projects. As a second-generation family business, we have strong values that aim to support our staff to define their personal aspirations and challenge them to achieve their goals. We have recently taken the company to the next stage in its evolution by transferring all of the company shares to a trust, entrusting the ownership of the business to the staff who work here.

We encourage our staff to take responsibility for their designs and we train them to manage projects efficiently to lead the design process. As such, the working culture at BPR fits well with the new working practices that are expected from teams in the BIM environment.

BIM requires a much greater level of collaboration, where every individual action should focus on making a positive contribution to the project. As an employee-owned business, we provide an open and collaborative environment, and it is common practice at BPR for information to be shared to support each other, knowing that this will be to the advantage of the business as a whole.

A positive working environment, based on trust: these values are essential to the success of the wider BIM project team, and the sharing of project data through an open and honest set of rules facilitates a collaborative design team, working together for the advancement of their projects.

The benefits offered by the preparation of good BIM data will have the greatest impact during the building's period of occupation, long after it has been completed on site. BIM should act to support the management of the building, to enable the facilities team to let space, control rental income, manage the cost of bills, maintain equipment and organise long-term repairs. The Government hopes to achieve the greatest savings in cost and carbon through the use of BIM systems during the period when the building is in use. But in order to achieve this goal, BIM projects need to be structured to suit the client's building management team's requirements from the early inception stage of the design process.

At BPR, we structure our projects to focus on the needs of the end user, by subdividing the project into zones and volumes that are structured to suit the building's functional requirements in use. BPR works in a variety of sectors, including further and higher education, rail and regeneration, and has found that each project requires a BIM structure that responds to the way it will be managed.

The BIM structure must also support the construction team to ensure that the supply chain receives relevant packages of data and that the contractor's project information model provides the building management team with a useful set of information. A properly structured BIM project will enable efficient workflow for the wider design team. It has also helped BPR to distribute work packages and responsibility across its own team of architects.

This chapter looks at how BPR Architects uses Vectorworks software as its primary tool for the preparation of good BIM projects. As BPR uses the functions within Vectorworks Architect — including workgroup referencing, design layers and stories — to shape a model, the results are then shared with the wider team by exporting to IFC.

Our BIM implementation

We found the recession of 2007-8 provided an opportunity to introduce new working practices to a smaller team, reduced by necessity. It was also at around this time that the Government published its intentions to press the industry to adopt BIM and to mandate that all public sector projects

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must be delivered using BIM Level 2 standards from 2016. Our key clients include a number of universities, Network Rail and a range of train operating companies, all predominantly funded by the public sector. We realised that we would need to adopt BIM working practices if we were going to be able to support our clients past 2016.

We initially established what this meant to our team and their training requirements, the type of software we needed and its impact on our hardware. We found that Vectorworks Architect already had the necessary capabilities to deliver architectural design information to BIM standards, and provided that we kept Vectorworks up to date, it would not be necessary to buy any new software.

To test the systems, we undertook a small BIM pilot project, replicating a set of drawings for a small gatehouse building that had already been completed and for which we had a very good set of example working drawings. The task I set myself was to prove that BIM methods could replicate the same level and quality of information that we were accustomed to achieving using 2D techniques.

We quickly realised that we were being far too ambitious in our determination to reproduce *all* 2D information from a single-source 3D model. It was a very useful exercise, however, for testing the capabilities of the software, demonstrating the potential of BIM to the more traditional members of the team, and pushing the limits of our hardware. The pilot project gave us the confidence to apply BIM methods to our live projects, knowing that we could still replicate the information we had produced in a 2D format as necessary.

This shift to BIM required us to fundamentally change the way we worked. Thanks to Vectorworks, we didn't have to change our basic CAD software, and this kept our training needs to a minimum. But we did have to change the tools that we were in the habit of using and, more significantly, the way we approached and developed the project.

The sequential development of the design became far more interactive. Rather than developing design ideas, then using a 2D plan to test the spatial arrangement before developing sections, elevations and 3D models, BIM allows us to develop all of these elements in conjunction with each other. BIM workflows enable architects to prepare a 3D model and to present a concept from which the relationship, size and hierarchy of rooms can be tested and plans, sections and elevations called off.

This change in thought process has had a positive and possibly fundamental impact on our ability to develop ideas and present the design proposal to the team. We can now explore challenging design ideas and quickly show how they might improve the project. We can also respond to requests for changes by other members of the design team, and test their effectiveness, without having such a significant impact on the design programme.

This process of change, however, can be difficult to adopt for experienced architects who have long since become expert at using traditional 2D techniques supported by 3D models. The natural enthusiasm to impress your client with a high-quality presentation, created using tools that you are familiar with, has had to be suppressed in order to ensure that we take the time to learn new tools and techniques, using the wider capabilities of Vectorworks Architect for BIM to better support our clients in the long term. A level of technical discipline has had to be imposed to ensure that everyone uses parametric tools and objects for all drawing elements that already contain IFC data, so

Finchley Road and Frognal Station
This design used BIM to co-ordinate information with the design team and engineers, and Renderworks to generate presentation images

that they are ready to be exported and shared with the other members of the design team.

The need for parametric objects has imposed a new way of using CAD. For example, a staircase is no longer designed using plans, sections and a calculator. Instead, the dialog box offered by the Stair tool asks the designer to enter basic numerical requirements, from which Vectorworks Architect will draw the stair in 2D and 3D. Designing by numbers can feel a bit remote for an experienced architect, but the solution can be rewarding and reliable, with the stair available for use in all drawing formats. Extra care needs to be taken, however, to ensure that the result is also elegant and achieves the desired level of quality of performance, and that we do not assume the Vectorworks software will design for us.

The choice of which tools to use, and how to use them to deliver the right level of information for the project stage, is key to managing a BIM project efficiently. Parametric tools are capable of saying too much too soon, which runs the risk that decisions appear to have been made long before they are agreed with the wider team. For example, the Wall tool can very easily illustrate components such as inner-skin cavity cladding at feasibility stage, long before the wall construction has been determined.

The effort we have spent over the last seven to eight years to embed BIM working practices in everything we do at BPR is now beginning to pay off. The information we produce is more robust, and we are able to share it with the other members of the design or client team. Most importantly, I believe our designs are becoming better as a result of being able to explore and test ideas with greater confidence.

Structuring the BIM project

A BIM project must be carefully structured to anticipate requirements for the building life-cycle. Information contained in the model could be used long after completion of the construction works, and the Government expects

> ***Much of the data is generated by Vectorworks Architect through parametric objects that are ready to deliver IFC and COBie data***

significant savings in cost and carbon to be achieved through improvements in building management. Savings during the design and construction phases only provide a small portion of the overall benefits of BIM compared to those available during the building's use.

The structure of the BIM model therefore needs to be considered in the context of how the end user will make use of the BIM data. Discussions with the building's facilities management (FM) team, and an understanding of the software they use, will have an impact on the strategic decisions that need to be made at the very start of a new project.

We are currently at a very early stage of developing systems that share data effectively with facilities management software. It is hard for building managers to anticipate how a new building will be used and managed, often some years ahead of when it will be finished and occupied, but thinking ahead is essential if BIM systems are to work effectively during the building's lifetime.

Much of the data required is automatically generated by Vectorworks Architect through the use of parametric objects, such as the Space Object tool, that are already structured to deliver IFC and COBIE data. Additional data can then be added in different ways, tailored to the client's individual requirements. For example, we can add the opening times for a room or the performance criteria for heating and lighting of the space in the Space Object, and the tangible benefits of improving access to and management of this data can be passed on to end users, or packaged as part of tenancy benefits.

We have found the process of dividing a project into zones and volumes presents a fundamental challenge which is critical to the management of the data in the long term. Zoning must be considered in terms of the end user's short-term and long-term building management regime.

For example, a commercial office block might be separated into three zones: External Envelope, Cores and Fit Out. This split would co-ordinate with the facilities management team's planned operations for each of these zones, in accordance with their different priorities and timescales, as follows:

i. The **External Envelope** zone may require occasional repairs or renewals. Window replacement programmes, for example, may be needed every 20 years, while routine maintenance to gutters and downpipes may require co-ordination so that scaffolding can pick up other minor repairs to walls, eaves and so on. The external envelope often remains under the control of the landlord or management company as a single owner

ii. The **Cores** zone would receive more regular attention, with a number of term contracts agreed for the ongoing maintenance of lifts, alarm systems, and vertical or horizontal services distribution systems. The ownership and liability for the cost of maintaining the cores can be more complex, and may require separate metering of supplies and separate billing to the various occupants

iii. The **Fit Out** zone may be leased to various owners and wholesale renewal of the internal partitions, ceilings and fittings may be carried out on a regular basis. The cost and responsibility for these works may lie with the tenant. The ownership of the BIM data associated with these works would therefore need to be separated from the other zones and lines of responsibility understood

The subdivision of a building into zones for a typical commercial building, as described above, is just one example of how zones could be used to define parts of a building to generate data and to structure the BIM information to suit the facilities management strategy.

We have found the principle of External Envelope, Cores and Fit Out zones also works well for some other building types, such as our residential and university building projects, where the management regimes have strong similarities. Universities often allocate internal areas to different faculties, who then take the lead on planning their internal spaces; and as long-term operators of the estate, they

Forum North, Middlesex University
BIM was used from feasibility to completion, with Space Objects assisting the workflow and procurement process

know the value of improved co-ordinated and tracked management and maintenance. Residential buildings can be subdivided into separate leased residential units.

The same structure, however, does not necessarily work for our railway station projects. Railway property has a much more complex ownership structure and responsibility for management. It is also difficult to define appropriate zones for some regeneration projects that are known to be speculative, where the design will be sold following a successful planning approval. The design and management strategy may well change before the construction phase.

Structuring the BIM project effectively to suit the end user can be difficult, and we don't always get it right from the outset. But once a zone structure has been agreed with the client team, it can then be used to examine the needs of the construction and design phases. Packages of data can be developed that align with the procurement contracts. Structural information, windows packages, partitioning packages, services and so on can be exported from the model to support the procurement process, in line with the long-term maintenance requirements for each zone.

An agreed system for the production of COBie data outputs can feed directly into existing FM systems, maintaining the integrity of the data between construction and use and acting as an intelligent part of an ongoing asset management and maintenance strategy. This tangible benefit offered to end users and building managers has allowed us to show clients the critical value of BIM and its significance as a method of data co-ordination and communication.

Zones also help to reduce the size of the individual data files that are worked on during the design phase. Using Vectorworks' workgroup referencing, we can distribute individual files to a number of architects who might be working on the same project at the same time. Each zone is prepared in a separate Vectorworks file that can be brought together through a master-plan 'all zones' file.

For larger projects, we also create a publications file from which we can generate all the 2D drawings and images. IFC data can be exported from the individual model file, with a separate IFC package for each zone. The management of zones has thus given us an effective way of organising the team, managing the size of the files, co-ordinating construction packages, and establishing working parameters that generate useful data for the client beyond completion.

Collaboration with the wider team

Taking our experience out of the office and sharing it with the wider design team has been equally rewarding. I introduced the concept of BIM to the design team for a new station project and found the BIM execution plan an essential tool for pulling everyone together around an agreed set of rules. The idea that we would all use the same set of codes for naming files, zones, layers, classes and so on was well received, but in fact the most extraordinary thing was that we had never done this before! There have been various attempts to standardise or codify naming systems, but they have been used by different organisations in different ways, and have tended to be overruled by the company's own internal quality management system.

The simple principle of using a single project code followed by a set of agreed fields for a file name is a big leap, but even on its own represents significant progress towards effective collaboration, establishing a baseline language from which we can all work. We have had to review our own quality management systems to facilitate BIM within our own company, because BIM is as much a process of how we communicate as it is a method by which we prepare our design proposals.

Hackney Central Station
Projects with a lot of repetition and standard components benefit especially from BIM workflows

> ***We can cut sections and view the information from any angle, identifying issues and producing intelligent clash reports***

Efficient communication with the wider design team is also dependent on properly defined zones and volumes. The structural engineer might take responsibility for the structural volume, which might overlap with the Core zone and External Envelope zone. Volumes can cross between zones, but are also classified as 'z' under BS 1192. We have therefore suggested the use of two digits for our zones: for example, Z10 for the External Envelope, Z11 for the architectural volume within the External Envelope, and Z12 the structural volume within the External Envelope.

The subdivision of a building project into parts can get very complicated — more so if it includes a number of buildings on the same site, which might also have different uses. I recommend time is spent with the client to carefully prepare the right zone strategy and to explain the long-term benefits of this initial approach for data outputs.

We are still testing a number of options suitable for different projects or sectors, but we are primarily relying on the principle that, provided that the definition of each zone and volume is agreed with the team from the outset and enshrined in the BIM execution plan, this established set of parameters and language will enable the communication systems and exchange of data.

The critical base information that enables different team members to collaborate — project code, location, orientation, levels, zones and so on — must be written into the BIM execution plan and then agreed by the team through the CIC (Construction Industry Council) protocol, which is now attached to our contracts of appointment. The plan also defines the BIM goals and schedules the deliverables that can then be produced from the model.

We have drafted a number of BIM execution plans to deliver pilot projects that enable us to test and develop the new regime. This allows us to respond to site constraints and use the capacity of the wider design team to support the BIM environment. We have identified and excluded areas of work that would be too complex to include in the BIM model, in terms of data management, compared to the benefits, and have identified wider team members whose design contribution sits outside the BIM process and who will not be able to contribute meaningfully to it.

For example, the preparation of a bill of quantities as a deliverable from a BIM project may be possible, but it would make a significant demand on the team to structure the data suitably. Take a carpet finish, which may appear as a component in the Floor Object tool. It might also be referred to in the Finishes schedule via the Space Object and be detailed in the specification. A direct extract of data from the model to create a bill of quantities would effectively measure the carpet three times, for each location in which it has been identified.

To date, our BIM execution plan has therefore excluded the production of a bill of quantities as a deliverable until the design team fully understand the implications of how they are preparing the data. The aim is to define what is expected from the model from the outset, which helps the team to control the production of data and manage their resources appropriately.

JOINING IT UP The really exciting outcome from working in a BIM environment comes when we bring several models from different sources together to co-ordinate the architects' and engineers' design proposals. We export from Vectorworks Architect to IFC and then combine the design models through an IFC viewer such as Solibri or Tekla. The federated design can then be examined to look at the spaces and identify any problems or conflicts.

The IFC viewers are very powerful and produce automatically clash detection schedules identifying where two objects occupy the same space. But this can often lead to an excessive list of minor conflicts that have little or no impact on the quality of the information available. For example, a door frame might clash with the Space Object, and it would seem unnecessary to draw the space around every architrave to resolve this conflict. Furthermore, the area of a space is normally measured to the line of the finished plaster behind the timber trim, and drawing around the trim would distort the area measurements. We therefore tend to use IFC viewers to undertake a visual check, and have found that the simultaneous display of packages allows for a superior efficiency of design check and co-ordination compared to the traditional review of separate packages of information.

We can cut sections and view the information from any angle, quickly identifying issues and taking snapshots to produce intelligent clash reports. These can be shared through the IFC viewer, so each member of the design team can amend their model and the federated model can quickly be updated with the new information.

Conclusions

Throughout this process, our role as architects and lead designers remains the same. We are still responsible for co-ordination and leading the design team, and BIM does not replace our duty to check and report on conflicts where packages must work seamlessly together. But BIM does provide some vastly superior tools to carry out this role, enabling us to improve accuracy and efficiency.

We see BIM as a form of communication that helps different consultants share information through a set of agreed rules which will help the team to understand each other's language. It has been compared to getting all the countries of Europe to talk to each other, without the need for any of them to learn a new language.

BIM requires us to undertake a cultural shift in the way we manage our design information, and it also requires that the design team be much more transparent and open about how this information is shared. As lead designers and BIM information managers, I believe that we now have an additional role: to nurture design teams, to bring them together around a new code of conduct, and to show them that the culture of trust developed through BIM can lead to significant benefits for the project.