

# A Search for Answers to Questions on BIM

*Is it the Future of Multidisciplinary Building Design?*

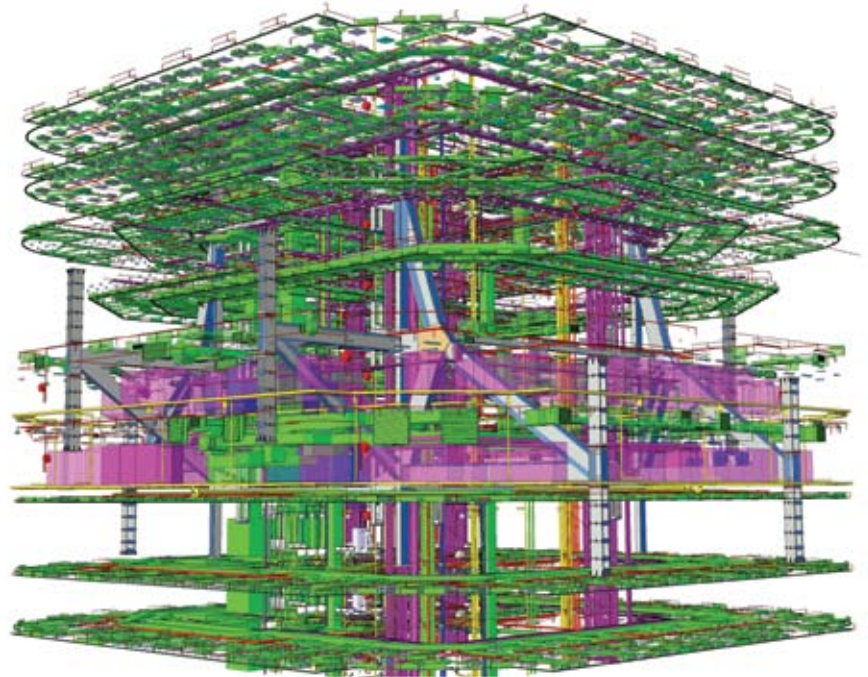
*By Zak Kostura, M.Eng, EIT, LEED AP*

It is funny how abruptly industries can change. I sometimes find myself imagining what it was like two decades ago when engineers, previously complacent to the conventional (and perhaps meditative) task of drafting designs by hand, suddenly found themselves compelled to use a mouse and a monitor to do what once was done by a drafting pencil and a sheet of paper. I wonder how frustrating it must have been to be an engineer seated at a work station and staring at his first empty drawing file on a tiny, monochromatic computer screen, contemplating the unfamiliar landscape that suddenly lay between himself and the single, straight line he needed to draw.

What would have made this especially daunting is a sinking feeling one might have while sitting in front of this new, glowing box that this fancy new way to draw a line might make the very familiar process of producing hand-drawn documents nearly obsolete. The merits of the new Computer Aided Drafting approach may be enough to smash the accepted convention, and suddenly change the way designs are developed, organized, communicated and realized.

It is no stretch to liken the uncertain times of the engineer at the initial advent of the personal computer to present times, as the broad expansion of computing power enables software developers to reinvent the design process yet again. New digital platforms enable a design team to create a single three dimensional model that incorporates and consolidates the work of every discipline and every party involved. The successful consolidation of all this data into a single, robust model can empower a designer with the ability to readily detect errors and clashes in the design, manage and coordinate modifications, perform analysis, produce construction documents, and export geometric information for fabricators, contractors, cost estimators and erectors.

Central to the new design approach is the collection, management and storage of data. The exercise of developing a virtual version of the intended structure in one of these new software programs is therefore rightfully called *Building Information Modeling*. The design information for an entire project can exist in as little as a single (albeit large) electronic file, accessed and developed by designers



*BIM model showing mechanical building systems.*

and drafters alike. All aspects of a design – structural, architectural, mechanical, and electrical, for example – could proceed in parallel, with multiple designers working on a single model simultaneously.

The merits of Building Information Modeling can be clearly drawn from the sea of documentation that has been written on the approach. Over the past several months, I began a detailed survey into much of this literature. The more I read, the more utopian the process seemed to be. Not a big surprise, as the lion's share of articles I could get my hands on were either written or sponsored by the very software companies that produce the modeling software.

There appeared to be a disparity between the success stories presented in the articles I read and the behavior of the engineering industry. Much of the technology has existed for half a decade, yet relatively few firms have begun to plumb the depths of Building Information Modeling. And, within those firms only a handful of projects are brought to final delivery using the new design approach. The number of subscribers to the new technology, in other words, did not look to be in sync with the spectacular benefits that purportedly went along with doing so.

The articles also said little about the evolving role of the engineer on these projects. CAD managers and project coordinators appeared to be well represented in

the related literature, but nobody seemed to be talking about the way in which this new approach impacted the structural designer. Beneath all of this new multidisciplinary coordination, clash checking and information management, were the old conventions of structural design and analysis still intact?

I decided to seek out engineers and CAD managers who had worked on large scale projects designed with Building Information Modeling techniques. My search for such projects took my sights overseas to Australia and the United Kingdom, where a substantially larger proportion of recent high-profile projects have used the new technology. I sought to find engineers with a broad perspective on the issue; individuals who have had experience designing structures through both modern and conventional approaches.

My discussions with these designers led me to understand three points that might explain why so many engineering firms in America and elsewhere have not yet bought in on the technology. First off, there is a tremendous amount of confusion that exists within the industry about what Building Information Modeling actually means. Taken alone, the name of the new technique is largely ambiguous and its abbreviation, BIM, is even worse. Given a trailing exclamation mark, it could easily be the name of a new laundry detergent.



Computer model.



Finished construction.

Much of the confusion lies in understanding what sets BIM apart from conventional 3D CAD modeling. According to Stuart Bull, a senior 3D modeling technician with Arup Australia, “3D modeling serves often as an interface for the data stored in a Building Information Model, but BIM itself is something beyond the simple geometric representation of building spatial properties.”

In CAD, a line is simply a line. A series of nondescript lines can be drawn to represent an object, such as a connection detail. But to the program, it is simply a set of one-dimensional elements. The high-level intelligence of an engineer is required to observe and interpret the lines as a complex object. Conventional 3D CAD programs can take the computational intelligence up a level and construct extruded shapes based on known centerline geometry, which can be recognized as discrete objects by the computer. The extruded shapes are not recognized as structural elements however, and anything beyond the general dimensions of the component are lost.

This is not so in a BIM environment, where the geometry of a structural element is complemented with stored information related to such characteristics as material properties, fabrication cost, construction tolerances and sequencing. Although the Building Information Model is almost always conveyed in the form of a 3D visualization, it is merely a mechanism for communicating the stored information in a concise and attractive format.

This confusion over the true meaning of BIM is exacerbated by a second point, which involves the extent to which it is used on projects that elect to use it at all. In many instances, design teams will bring a Building Information Model online late, or bail out prematurely. Because of the ubiquitous 3D visualization platform, such high-level models make excellent marketing tools. Efforts to integrate BIM into a design process are therefore sometimes half-hearted, yielding an attractive if incomplete end product.

Maurice Drake is a structural engineer with Ove Arup and Partners in the United Kingdom,

and served for more than five years as structural team leader for the \$655 million Terminal 5 at London’s Heathrow Airport. In a recent telephone conversation with Drake, he explained to me the development of a massive Building Information Model for the project, and stressed the importance of buying in all the way with the new technology.

“The 3D modeling [BIM] environment was good for large scale changes that had major impacts to many of the final drawings. But in the later stages of design, it became harder to justify making small changes – such as moving the edge of a slab – to the model, when it was



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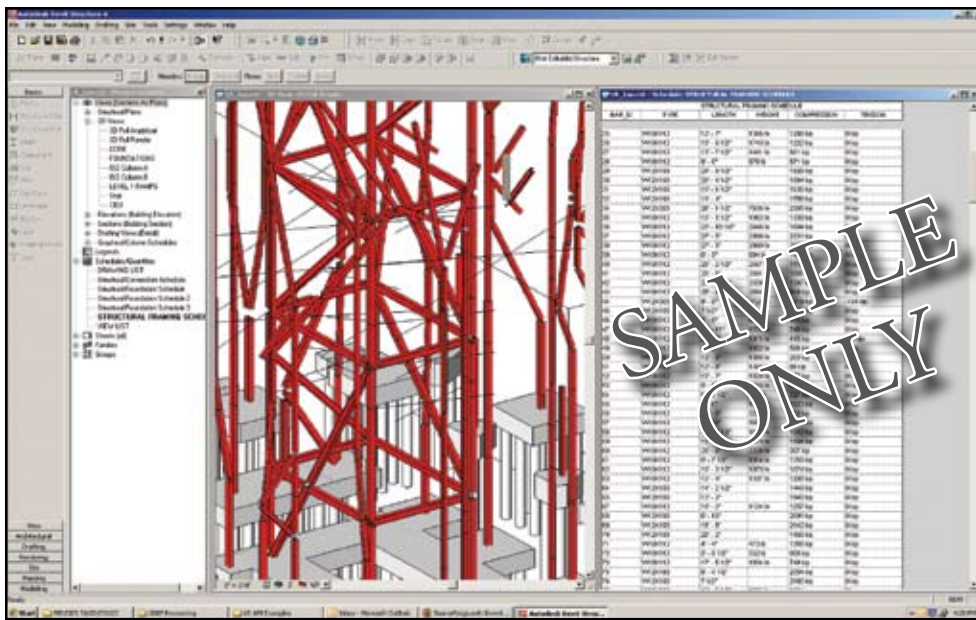
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A Revit structural model of a parking garage in Miami. Courtesy of Buro Happold.

so easy to just change it in the 2D drawings. Of course if you do that, your modifications aren't saved with the global model, and you lose the benefit of the centrally-stored design." It is easy to make minor changes directly to the 2D drawing sheets that precipitate from the model, Drake explained, but doing so causes the model itself to fall out of date. It compromises the true benefit of storing data with the Building Information Model, which is intended to continue serving as a tool long after construction documents are submitted.

A third point can be made on the evolution of the technology behind Building Information Modeling. Software packages produced by firms such as Autodesk, Bentley, and Gehry Technologies remain in a state of perpetual reinvention, and the capabilities of their products change practically on a month-to-month basis. Their research and development departments work intensively with design firms that use their software, in an effort to identify and address the needs and frustrations of engineers and drafters. By most accounts, it will take several more years for the software to reach a level of relative stability. In the meantime, many design firms – particularly small ones – have opted to wait for the technology to mature before making substantial investments.

Through my discussions with Stuart Bull in Australia and Maurice Drake in UK, I made inroads into understanding why the energy and enthusiasm expressed in articles and seminars on Building Information Modeling have not matched the attitude of the engineering industry. At the same time, their individual work with the new technology has returned astonishing results. Each spoke of cases in which BIM allowed design teams to accom-

plish design feats previously unimaginable and envisioned how the new approach can be taken to the next level.

In Australia, Building Information Modeling was used on a rehabilitation of the Sydney Opera House. Originally intended as an acoustic model, this multidisciplinary tool spread quickly to encompass structure and architecture. The project team used the model to explore a number of very unique design options, and the electronic file allowed for the rapid production of models in remote offices around the world, facilitating critical feedback from design professionals in distant regions.

For One Island East, a 67-story tower project in Hong Kong, Gehry Technologies went so far as to establish a full-time BIM office adjacent to the building site, where architecture, structure and building services were consolidated into a single virtual model of the design. The model provided designers with the opportunity to easily coordinate system layouts. The contractor used the resulting model to develop and maintain a detailed construction sequence that could be refined through the entire construction process. According to publications on the project, the owner anticipates a 10 percent overall cost saving and a significant reduction in construction time as a result of using BIM.

Maurice Drake expressed satisfaction with similar technologies on the massive Heathrow Terminal 5 project. This technology, known regionally as a Single Model Environment (SME), was implemented on the project in the middle of the design phase and permitted the design team to turn outdated 2D drawings into a real time 3D model, managed and developed by designers and drafters. It permitted

detailed construction sequencing for at least one building in the complex, and by early 2006 this Single Model Environment had been accessed and edited by 473 CAD users and 3,789 other document users.

As an experienced engineer, Drake was able to go farther in our discussion and interject on the potential for BIM to alter the role of the design engineer on a project. On the Heathrow job, management of the virtual model was maintained by a CAD manager of sorts. A team of drafters worked directly with the Single Model Environment to implement the engineers' designs to the central database. From his perspective, the role of the structural engineer had changed little if at all with the implementation of the new technology.

Along with this observation came a few words on the future. As modeling software continues to grow in reliability and sophistication, direct links with structural analysis software grows increasingly feasible. While the opportunity existed to use the global model as a basis for structural analysis, it was not taken by the Heathrow T5 team. Drake noted that, on future projects however, BIM technology could permit the design engineer to save a substantial amount of time that is currently devoted to creating and maintaining independent structural models.

While there remain many reasons for engineering firms to be wary of the new technology, an even larger number of benefits lie in its successful integration. This relatively young technology may not yet be readily accessible to everyone. But my conversation with progressive and forward thinking engineers and CAD managers around the world has suggested that structural engineers, like their hand-drafting counterparts twenty years ago, should prepare to pick up a mouse and embrace new technology. ■

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