The Dots Are Connected in Today's Digital BIM Workflow

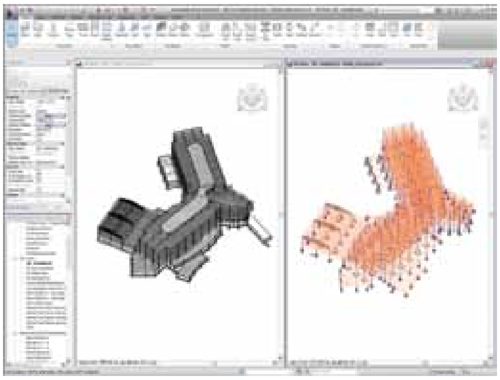
By Robert Middlebrooks, AIA and Scott Hammond

The process of design through the creation of 3D models is a concept and practice well known to structural engineers today. Less familiar may be a fuller perspective on the current state of Building Information Modeling (BIM) and the enormous progress in digital workflow over the past few years. BIM is an integrated process for exploring a project's key physical and functional characteristics digitally – before it is built. The resulting information helps architects, engineers, contractors, and owners to see, prior to construction, what the design will look like and, more importantly, how it will perform. This visibility enables all members of the project team to contribute to its success through better coordination, improved accuracy, and the ability to make better decisions earlier in the process.

At present, BIM can be characterized by a level of integration that only a few years ago would have been considered amazing, if not impossible. Five to ten years ago, a structural engineer typically operated in a "silo," carrying out independent analysis by either creating stand-alone models or loading limited geometrical data from the software used to document the structure into an entirely separate application. This tedious, error-prone and costly way of exchanging data did not produce a view embracing all optimal solutions or possibilities. The "dots" in this scenario were not connected. What is efficient is to bring engineering analysis and design under the umbrella of integrated models that are based on decisions made through analysis.

Today we find ourselves in a world where BIM is characterized by an integrated, collaborative effort that occurs throughout a project's timeline. Structural engineers perform discrete tasks such as analysis, design alternative comparison, visualization, clash detection, 4D, and so forth. These activities are now connected to, and more fully integrated with, the BIM process and software used by the entire design team. Thanks to huge efforts in the software community to integrate design and analysis, structural engineers operating within a BIM environment can now iterate, refine, and optimize based on not only structural criteria, but also related factors such as cost, sustainability, and constructability. There are no dead ends in BIM, as every step adds value to the project.

Through the contributions of engineers directly involved in BIM, various structural forms and scenarios can easily be evaluated. Engineers can enjoy near-real-time comparisons among options, examine quantity takeoffs, and consider life-cycle issues. The ability to evaluate alternative designs at any stage in the workflow can help facilitate fully informed decisions that go well beyond the simple "lowest cost" approach.



Structural engineers can now work with, and dynamically contribute to, a 3D intelligent model created in BIM applications and become more involved earlier in the project. The model enables them to develop conceptual designs and quickly respond to an architect's changes. With current analysis software operating in a BIM environment, engineers take a complex 3D structure and evaluate various structural configurations to produce an optimal design based on analysis at the preliminary stage.

To illustrate further the value of BIM, consider the vast improvements when it comes to bringing the results of structural analysis into construction documents. In the past, the structural engineer would go through a separate step to modify and coordinate construction documents. This disjointed process required re-inserting data to correct original drawings. BIM now allows an efficient, linear, all-digital workflow that puts structural analysis closer to design and documentation. Engineers can make decisions based on the core BIM model that, in turn, generates construction drawings directly.

BIM also enables a much closer integration between the structural engineer and fabrication. The close integration of analytical and detailing software in a BIM environment means that structural engineers can investigate extending their models to communicate engineering design intent more clearly and easily to various construction stakeholders. This opportunity, in turn, provides the structural engineer with an expanded range of marketable services.

While great strides continue to be made for structural engineering offices' internal processes with BIM, there is still work to be done across the industry. According to a 2009 McGraw Hill SmartMarket Report, *The Business Value of BIM*, the most limiting aspect of BIM is the lack of interoperability between software applications. Nearly 80% of BIM users say there is significant need for improvement in this area. Some of the challenges lie in the numerous unique interoperability standards for different construction materials. For steel, there are two such standards, SDNF and CIS/2. The precast concrete industry chose the upcoming IFC 2x4, and ACI is in the process of investigating how to ensure that there is complete interoperability for all things concrete. The different methods and file formats used in structural engineering do not necessarily reflect a lack of communication and willingness to work together, but are more representative of the complexity of the field. While interoperability will continue to be a great challenge for all parties involved in BIM, industry groups and software vendors continue to work together to close the gap and meet the needs of all parties.

Structural engineers have a long history of 3D model-based analysis and design, and are now joining other professionals in adopting BIM. As the benefits become more refined, this will bring about entire ecosystems in which all project stakeholders, including structural engineers, will ultimately become involved with full virtual design and construction.▪

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