But It Worked in THE MODEL!

BY DAVID RUBY, SE, PE

Models are great tools for designing structures, but they aren't infallible. They require the application of sound judgment and experience to reach their full potential.

THE WORLD'S SKYLINES are resplendent with architectural masterpieces that challenge traditional limitations and exceed our wildest imaginations.

Today's most brilliant designs achieve structural feats never dreamed of in decades past, characterizing a true revolution in the building industry. We have reached a threshold upon which possibilities seem limitless, and designers across every discipline must transcend boundaries to achieve distinction. The question is: Will we, as structural engineers, be able to adequately provide the expertise and service that this movement demands?

Three potential roadblocks exist. The first is an apparent "design versus construction" culture or a perceived lack of trust between designers and contractors. The second is the increased reliance on building information modeling (BIM) as truly the best thing since sliced bread! And thirdly, with only a minimal apparent benefit for architects and engineers, there is reluctance within the design community to view BIM as anything other than a substitute for two-dimensional documents or as an optional contract document delivery method.

◀ Design and construction: a collaborative process built on trust and common goals.

▲ The Hard Rock Stadium canopy installation in Miami is an example of collaborative design, involving Alberici Constructors, Hillsdale Fabricators, Thornton Tomasetti, Hunt Construction Group and Ruby+Associates.

If we are to remain competitive and successful, the design community must confront these issues. A resolution may be buried beneath the distrust between designers and contractors or hidden within the design and construction industries' silos of knowledge. Discovering a solution, however, demands a paradigm shift in design firm procedures and, perhaps more importantly, a shift in attitude—an acknowledgement from engineers and designers that the construction team is not the enemy and an agreement that BIM provides the design community with an unmatched collaborative communication vehicle. We must embrace a collaborative environment focused on design and construction together as a true team effort.

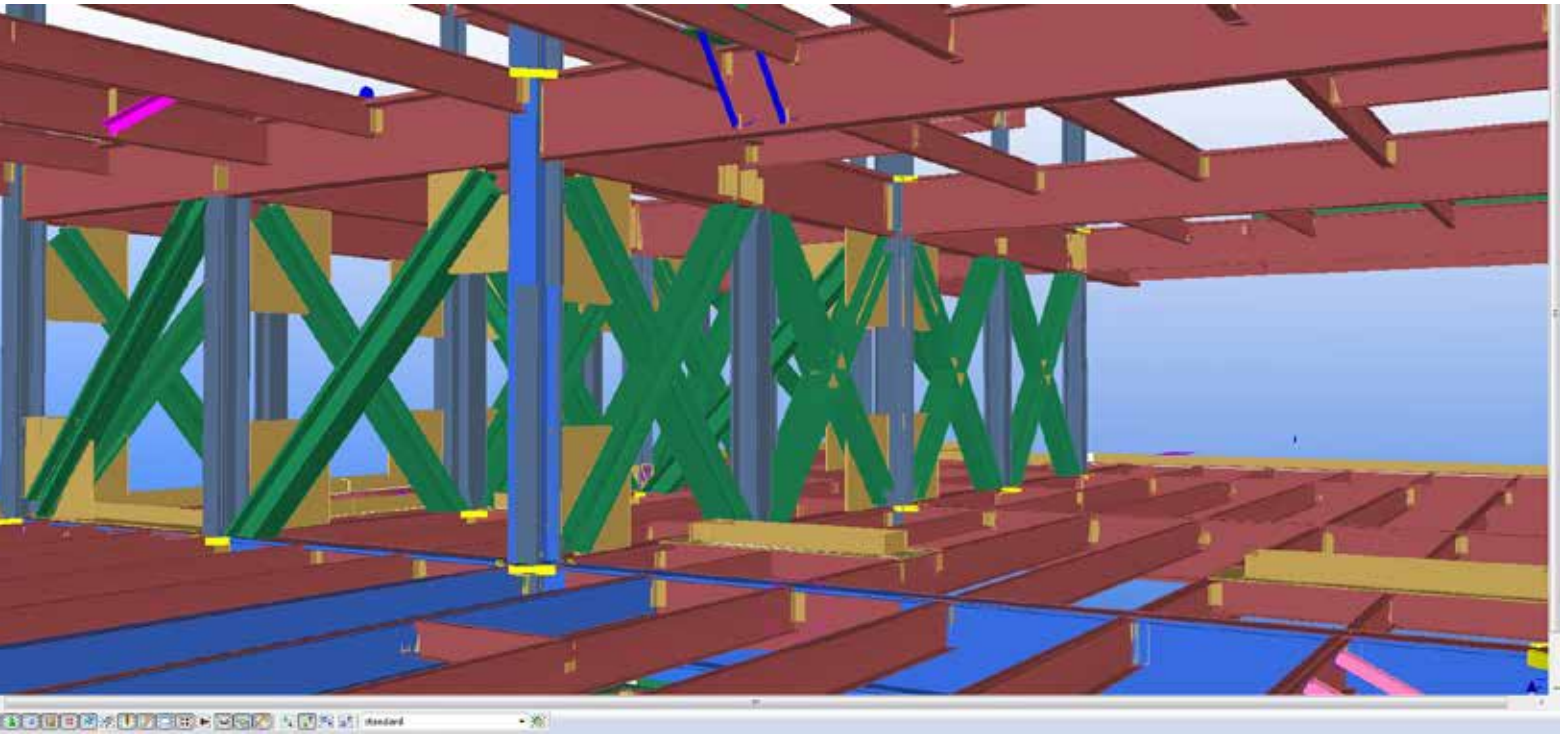
BIM + Knowledge

In simple terms, BIM is an enhanced means to communicate the elements necessary to meet an owner's needs and expectations. BIM is populated with data related to material, geometry, finishes, details and connections. This data goes far beyond the content of typical design documents. However, BIM is not a magic pill nor is it a substitute for well-prepared contract documents. BIM requires supplemental information, such as the infusion of construction knowledge on the fabrication and installation of building systems, to represent a complete package.

While the owner's demand for BIM has begun to break down our industry's "knowledge silos," contractors and construction managers have already discovered that BIM can assist with estimating, presentations, scheduling, coordination and project control, as well as enhance a project's total success and profitability. Many of today's successful design-build teams are also using BIM to enhance their designs and profitability. Design-build teams, comprised of experienced designers and knowledgeable construction professionals, collaboratively develop their designs. These teams are successful because they make every attempt to maximize their construction knowledge and experience in planning, design, procurement and field operations in order to achieve overall project objectives—all with constructability as the common goal.

The design community, however, has been slower to see the benefits of BIM. Instead, many see it as an additional investment in software and training without apparent payback, and others feel BIM requires extra man-hours without associated

Dave Ruby (druby@rubyandassociates.com) is the chairman and founding principal of Ruby+Associates Structural Engineers in Bingham Farms, Mich.



Modeling allows for virtual construction but must be combined with engineering know-how to yield positive real-world results.

compensation. Some believe that because BIM is making designer's jobs "easier," fees should be reduced accordingly.

Room for Error

The transition from paper to screen was certainly welcomed with open arms, considering the tedium of structural analysis and the frustratingly iterative nature of structural stability confirmation. As computer programs simplify the analysis and design process while maintaining accuracy, structural engineers and our cathedrals of higher learning are increasingly less dependent on raw hand calculations. Students and young engineers have become perhaps too reliant on the simplicity and analytical capacity of computer-aided design.

Furthermore, these design programs are at times too easily assimilated into the BIM process, often without an engineer's final review of the output. Undeniably, the benefits to others are obvious, but the divide that has occurred between "what is" and "what was" leaves many gaps in the design development process and, some would argue, too much room for errors of omission or oversight.

Where (and how) does it All Fit in?

When considering the concepts of BIM, constructability and collaborative design, here are a few questions to ask yourself:

- Do you see the relationship between constructability and collaborative design?
- What benefits might your organization reap from an integrated, collaborative design process?
- Do the concepts of constructability and collaborative design fit with your office's current design philosophy?
- If not, would the introduction of constructability into the collaborative design process provide an improved project requirement communication platform through BIM?

Bridging the Gap

Collaborative design via 3D models certainly provides material, geometry and framing data, but a significant amount of additional information is necessary to properly estimate and develop an accurate bid. This information—such as general notes and specification, tolerances, lateral-load-resisting systems, shoring or jacking requirements or interrelationships of the structural steel with nonstructural steel elements—may not be included in the model. BIM is only the beginning, and this necessary "extra" information goes beyond the boundaries of the typical computer model.

To tackle these issues, we must first accept the nature of available technology; it is neither all-inclusive nor self-sufficient, but rather an instrument that enhances the design process. Advanced technology does not account for all aspects of design or for unique design concepts and structural stability

during installation. Too often, our design responsibility appears to be limited to document preparation only, and our acceptance is based on the computer results, with our claim, "But it worked in the model!"

Potential for Inaccuracies

The computer, whether performing analysis or 3D modeling, must serve a subordinate role to the structural engineer. It is the structural engineer, with his or her strong foundation in the principles of structural design and an understanding of constructability concepts, who must remain the primary source of the design. Under the highly defined parameters by which most systems operate, rudimentary oversights in modeling and data entry may go undetected and lead to erroneous results. These inaccuracies in turn may continue to go unnoticed as the model reflects blue and green.

As is often the case, the structural analysis programs perform design checks based on specific structural boundary conditions. The structural design results and boundary conditions must be conveyed in the model. If not, such action undermines the functionality of BIM as it relates to structural analysis and the decision process.

Mentorship is Key

As students, we spent countless hours studying and developing our understanding of the basic fundamentals of structure, and believed that upon graduation, we would become engineers. Soon, though, we became aware that our education as engineers actually begins when we enter the workforce. It is then that we become aware of what we do not know, which tests our understanding of structure. Through mentoring by accomplished and practicing engineers, we grow with each professional experience, with successes and failures, each leading to a unique collection of invaluable resources.

Life's experiences comprise a tool more valuable than any computer program or model. Our random access memory is generated and acquired through our own personal experiences. We need these experiences now more than ever with the advent of BIM. The need for a strong foundation in the basic principles of structure as well as the advantage of construction experience and knowledge is amplified by computer-aided analysis and the generation of BIM deliverables, not displaced by it. Our ability to confidently evaluate a given situation as a result of our knowledge and experiences is an invaluable tool essential to effective design solutions.

It only takes a slight oversight, a trivial error or a simple misunderstanding to compromise the success of a project. Too often we find the source of a problem stems from incomplete communication related to the structural concept, a misinterpretation of boundary conditions or simply an undefined load path. These are the elements of design where experience is irreplaceable. ■