BIM Power: Interoperability

By Andrew W. Gayer, P.E., S.E., LEED AP, M. ASCE

If one were to compile a list of the latest buzzwords for the A/E/C industry, BIM (Building Information Modeling) would arguably be at the top of that list. As structural engineers who are continually searching for ways to produce project deliverables better and more efficiently, we are naturally curious about BIM and have a lot of questions: What is it? Does it really work as advertised? How does it help my firm be more accurate, efficient, and profitable? Can it really help me today?

With all that is promised by BIM, structural engineers could be justly excused if they feel overwhelmed by the visions of grandeur surrounding the topic. But, of all the advantages that BIM offers to the industry, interoperability is one promise that is delivering real benefits today.

Imagine, if you will, the following scenario…

Your firm has just landed a hot new project: a multi-story, steel framed office building atop a multi-story, post-tensioned, cast-in-place concrete podium that is on a fast-track schedule. The project is located in a high seismic region and the local building official requires a push-over analysis. Also planned for a portion of the office tower is a fitness center, which will offer aerobics classes throughout the day. Due to the fast-track schedule, both the structural steel fabricator and the concrete formwork supplier have made requests to obtain your 3-D model, in lieu of paper drawings, on a weekly basis during the design process in order to get a head-start on their detailing. At the same time, the construction manager is requiring weekly updates of structural quantities in order to maintain control over the budget, which is of primary importance to the project developer.

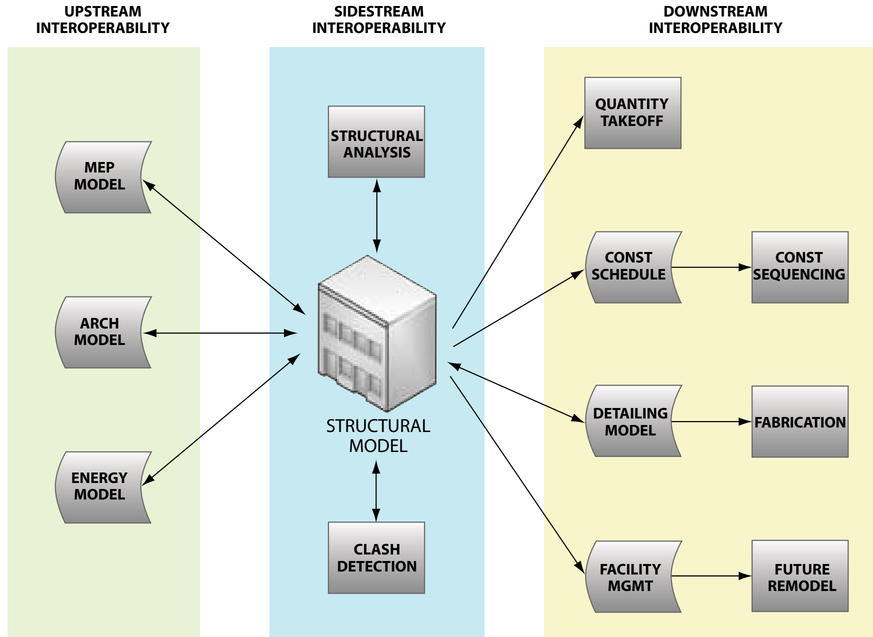


Figure 1: Potential interoperabillity work flows.

In an effort to eliminate waste and duplication of effort, you decide to utilize a BIM process for all structural modeling and documentation. The analysis and design can then proceed through a series of round trip efforts through the various structural analysis software packages being used, each retrieving from and storing to the structural BIM database as required. The utilization of BIM also allows you to share, via weekly emails or ftp updates, a highly accurate 3-D model with the subcontractors while also providing the construction manager the ability to pull material takeoffs for cost estimating.

Does the BIM solution to the project sound too fantastic to be real? Do you not believe that the technology exists today to perform such seamless integration? A data rich structural BIM database offers a multitude of opportunities to save time and money, while increasing accuracy by capitalizing on the interoperability capabilities of the BIM software (*Figure 1*).

Whether the interoperability a structural engineer seeks is upstream with the architect linking the structural BIM into the architectural BIM for clash detection, sidestream with the structural engineer automating data transfer of steel beam design (e.g. beam size, studs, camber, and end reactions), or downstream with the contractor pulling quantities directly from the structural BIM, the technology does exist today to exploit the use of BIM for a structural engineer's interoperability needs.

Structural engineers will typically use BIM interoperability in many different forms. The easiest and simplest form of interoperability is by using software that can directly read the proprietary file format native to the BIM software application. One example of this direct interoperability comes when different

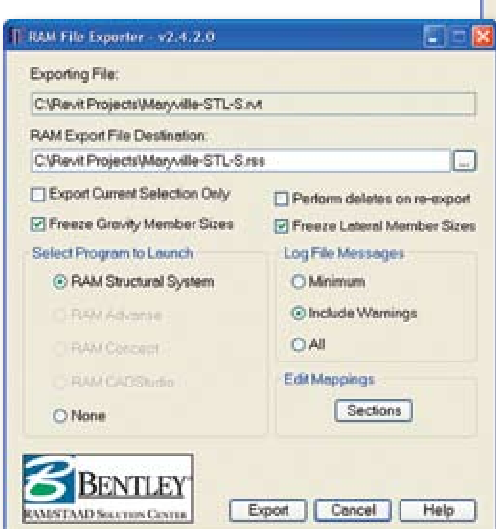


Figure 2: Dialog box for exporting from Revit Structure to RAM Structural System.

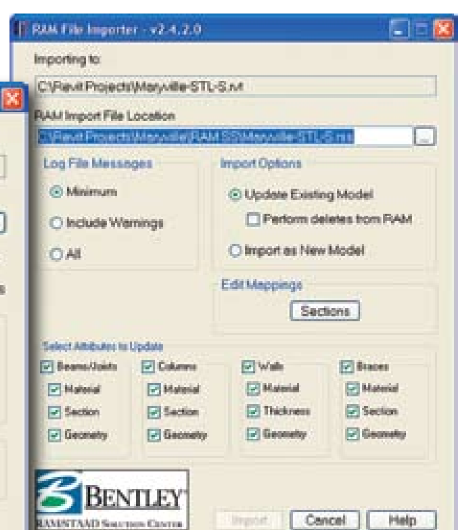


Figure 3: Dialog box for Importing from RAM Structural System to Revit Structure.

applications of the same software suite are being used, such as when a structural engineer links a Revit MEP model into the Revit Structure model in order to coordinate piping penetrations. A second example is an outgrowth of BIM software vendor agreements to share their proprietary file formats (i.e. the announcement by Autodesk and Bentley to advance A/E/C software interoperability in July 2008).

This type of interoperability, while very powerful and easy to use, is also very limited. Seldom do structural engineers perform all of their work using tools from the same software vendor, nor do they hold sway over software use decisions of other design team members.

A second type of interoperability comes when software vendors incorporate an Application Programming Interface (API) into their product. An API is a set of routines, data structures, object classes and protocols provided by libraries in order to support the building of applications. By exposing a well defined set of functions, the BIM software vendor allows other software vendors, as well as structural engineers to develop an interface between the BIM software and various other computer programs. Many software companies and structural engineers have taken advantage of this form of interoperability to write translation programs that allow linking of data between a structural BIM and structural analysis software.

For example, Bentley has created an interface between Autodesk's Revit Structure and Bentley's RAM Structural System that allows for round-tripping of design data. By using the link software (which relies on APIs in both Revit Structure and RAM Structural System), a structural engineer can begin the modeling process in Revit Structure, export the BIM geometry to RAM Structural System (*Figure 2*), cleanup the transferred geometry and add loads, design the beams, and then send the updated beam sizes, camber, and end reactions back to Revit Structure (*Figure 3*). The structural engineer can then reframe a bay around a new stair opening in the structural BIM and perform the transfer process all over again. This process allows a structural engineer to take full advantage of interoperability with the structural BIM to eliminate mistakes common to the engineer/red-mark/drafter/backcheck traditional workflow.

While interoperability through APIs is flexible and very common today, it does require many different translators to be written (one for each different program that wants to interact with the BIM software). Also, if the API is poorly written or does not expose the proper functions, its usefulness will be degraded. For example, when transferring data from Computer and Structures' ETABS to Revit Structure, material properties that were modified in ETABS will not be updated in Revit Structure because the Revit Structure 2009 API does not allow updating of material property parameters.

Finally, a third type of interoperability comes when software vendors support the use of open data exchange formats. Through the use of open standards, such as the Industry Foundation Classes (IFC), all software vendors can concentrate on creating one translation application which can serve many different programs. The IFC specification is a neutral data format to describe, exchange, and share information typically used within the building and facility management industry sector. The IFC specification is developed and maintained by buildingSMART International (**www.buildingsmart.com/bim**).

An example of where the open standards approach has been successfully implemented is the steel industry's development of CIMSteel Integration Standards (CIS/2). In developing the CIS/2 standard, the American Institute of Steel Construction (AISC) created an open file format that can be written and read by many different types of software applications (e.g. BIM, structural analysis, detailing, fabrication) very easily.

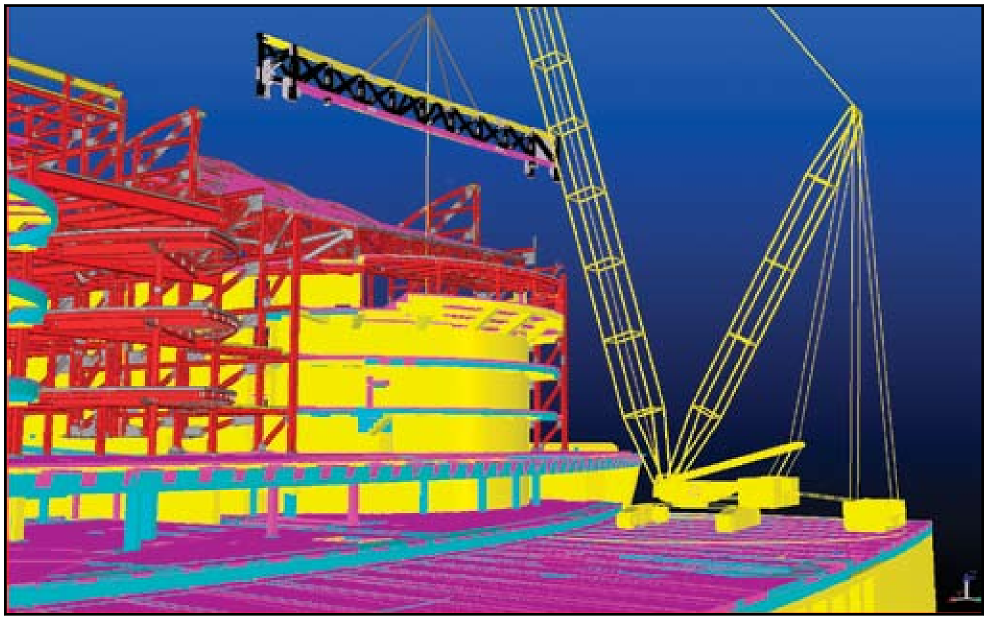
continued on next page

While interoperability through open standards is full of promise, the lack of robust infrastructure and limited implementation surrounding predefined exchange formats limits its usability. As such, efforts like the ATC-75 Project are currently underway to augment the current IFC definitions to enhance their usefulness for structural applications.

In the A/E/C industry today, structural engineers are under an ever increasing set of demands to produce work faster, at less cost, and with higher quality. By our nature, structural engineers are problem solvers and continually search for ways to leverage the latest technology to produce our work. Today, that includes embracing BIM and interoperability.

However, as described above, there is no one standard method for achieving interoperability; likewise, there is no standard definition of what structural engineers expect interoperability to be. But as the software industry progresses from direct file formats, through APIs, to fully embracing open standards, structural engineers can use the power of BIM to develop their own unique process of software interface that works best for their firm today.▪

APIs and IFCs will be expanded as the subject of a future article.



Tekla Structures image showing a critical lift and crane sequence at the Kauffman Center for the Performing Arts. Courtesy of Ruby + Associates, Inc.

*Andrew W. Gayer, P.E., S.E., LEED AP, M. ASCE, is a Vice President and a Structural Engineering Principal with HOK in St. Louis, MO. He can be reached at **andrew.gayer@hok.com**. Andrew is a member of the Joint SEI-CASE Committee on Building Information Modeling (**www.seibim.org**).*