BIM Interoperability

The Promise and the Reality

By Bruce A. Burt, P.E.

This is the third in a series of articles authored by members of the Joint SEI-CASE Committee on Building Information Modeling.

Building Information Modeling (BIM) is rapidly gaining acceptance as the preferred method of communicating the design professional's intent to the owner and project builders. These data-rich models can be used by other members of the design team to coordinate a building's various systems (such as electrical or mechanical systems) or identify interferences (*Figure 1*). In addition, members of the build team can use these models as input for preparing fabrication drawings, ordering materials, developing construction schedules or preparing erection sequences. There is even software and hardware that will allow the site surveyor to interface the building column grid with GPS data, significantly automating the process of staking out the construction site – be it a building, roadway or underground utility. The owner can use the model as an archive of as-built information, and a repository of materials, finishes, even equipment, contained in his building. Whereas perhaps five years ago the long-term viability of this new modeling method was uncertain and its rate of adoption unknown, it is now clear that Building Information Modeling represents the future of building and infrastructure design and construction management delivery. It is no longer a question of *if* BIM will be widely adopted, but *when*. And the when is sooner than we imagined just five years ago. Many structural engineering firms, large and small, have already transitioned to a primarily BIM-based work process.

There are many reasons for this conversion, and they are not necessarily based on client demands. Granted, many of a structural engineer's efforts in converting to BIM will benefit other members of the architectural, engineering and construction team, as well as the owner. Some engineers have complained that they are being forced to transition to an expensive and not thoroughly proven new format, and their investment principally profits these other stakeholders. But engineering firms who have fully committed to a BIM-based work process have realized many benefits in the conversion, some of which are as follows:

- Increased productivity in document development
- Better coordination of in-house project documents
- Better communication between design team members
- Fewer RFI's
- A faster, less labor-intensive shop drawing review process where paper approval drawings are virtually eliminated
- Maintaining leading-edge technical capabilities

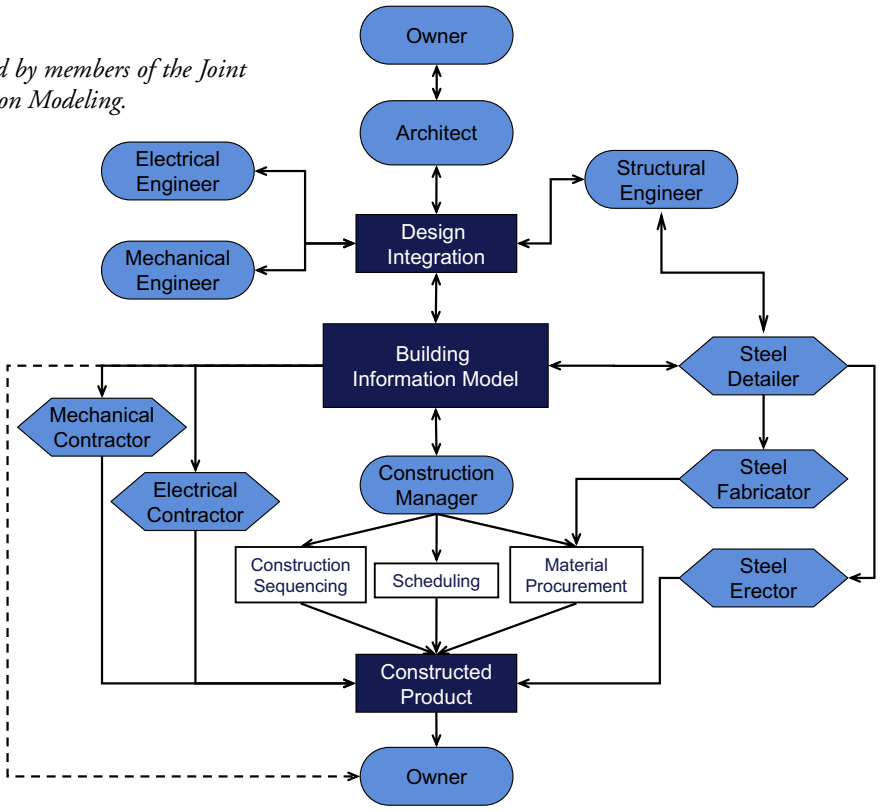

Figure 1: A BIM Project Flow Chart.

Yet despite its increasingly widespread use across the design and construction spectrum, in some respects Building Information Modeling is still in an early developmental phase. Its inherent data-richness creates gigantic data files. This mass of data, combined with the large number of collaborators in the design and construction process, creates a jumble of data that must be classified and arranged for the information to be freely exchanged. The BIM community is likely only in the early stages of mastering this huge array of data, users and software.

The Role of Interoperability

A key to BIM's adoption as the principal design delivery method is the ability of the various team members to easily share building data. Software developers and others are busily at work attempting to enable information interchange among the myriad of software programs employed by project team members during the design and construction process. As Andrew Gayer explained in the preceding article in this series (BIM Power – Interoperability, October, 2009), interoperability between various software applications can be achieved in a number of ways. Three of the most common are:

- Using software that directly reads the proprietary file format contained in the BIM software application. This may be the case for a suite of software applications developed by one software vendor.
- Using software that incorporates an Application Programming Interface (API), providing (at least in theory) a well-developed interface between software from different providers.
- Using software that supports data exchange standards having industry-wide acceptance. The steel industry's CIMSteel Integration Standards (CIS/2) is an example of a successful application of a data exchange standard. The Industry Foundation Classes (IFC) are intended to provide a neutral model framework that will integrate a variety of design

and construction management software into a Building Information Model. Work continues on developing a CIS/2 to IFC translator, which should greatly enhance data exchange within the steel segment of the BIM environment.

All of these methods of data exchange are currently being used, with varying degrees of success.

Interoperability between Analysis and Design Software and BIM Software

The interoperability issues of the design/construct community are mirrored in the structural engineering profession. There are dozens of analysis and design (A&D) programs available for modeling various aspects of a structure. Most engineering firms have several of these tools at their disposal. In the course of a project's design, engineers usually employ one or more of these modeling tools. However, the graphical representations of the engineer's designs traditionally have been rendered in a CAD-based set of design drawings. These CAD drawings are usually created "from scratch," with very little interface with the three dimensional models created in the design process. In addition, there is little, if any, data embedded in an AutoCAD file that can be used by clients or other members of the design or construction teams. In other words, CAD drawings are little more than electronic versions of the manual drawings created in an earlier era.

A significant process improvement can be achieved by integrating the models created for analyzing and designing a project with a Building Information Model that will be delivered to the client (either as an electronic file, or, more typically at this stage of BIM's evolution, as a conventional set of two dimensional plans, sections and details). BIM software currently does not offer design or analytical capabilities; these are still the purview of A&D software such as RISA 3D, RAM Steel and SAP2000 and many others. In order for a single model to be created that will serve as the design tool and the deliverable, interface between A&D and BIM software is critical. The BIM software companies are developing these interface tools. However, due to the various BIM and A&D software in existence, and the fact that a standard format for interoperability such as IFC is still developing, many of these links are being developed on a proprietary basis between various software developers. Some engineering firms with the resources and expertise are creating their own API's, though this option is not feasible for most firms.

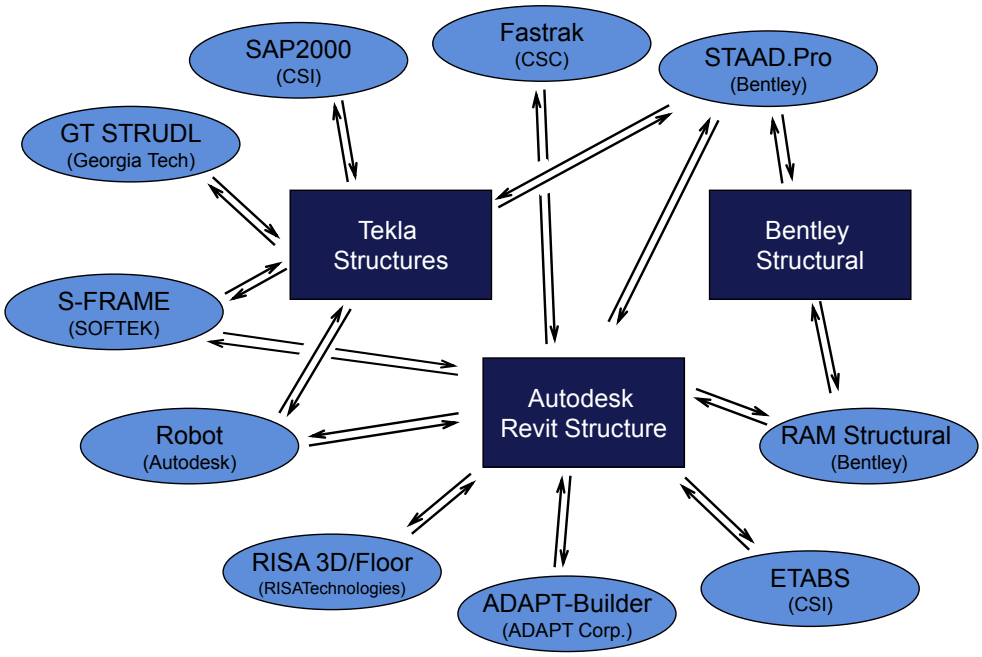

Figure 2: Interoperability Between Analysis & Design Software and BIM Software. With contributions from Lisa Willard, P.E., SE Solutions, LLC.

Impediments to Interoperability

Though all major A&D software provides interoperability with one or more of the BIM software (*Figure 2*), the devil is in the details, and as we engineers know, there are many details involved in accurately rendering a complex, three-dimensional structural model in a collaborative environment.

In a BIM-based design delivery method, the first step in the modeling process is choosing the software in which to initiate modeling. Depending on the software, model migrations may work best when the model is initiated within either the BIM software or the A&D software. For the model to successfully migrate from BIM to A&D software or vice versa, careful attention must be paid to member work lines, member orientations, element definitions, and a host of other parameters. Even if the initial model is created with the greatest care, mistranslations occur that must be manually fixed in the subsequent model.

In the case where modeling is initiated using BIM software, once the building information model has reached an appropriate stage of development, it can be migrated to the A&D software. Design takes place, and the revised data is migrated from the A&D model back to the building information model. Additional changes that take place after the creation of these dual models can require significant model maintenance, with repeated merges of

the A&D and BIM models. Over time, this "round-tripping" of data from one model to another can lead to data loss and a loss of model accuracy. Oftentimes, the solution is to sever the link between BIM and A&D models prematurely, or perhaps abandon the process entirely, so that two models are developed and maintained, serving two disparate functions. This unfortunate result represents a missed opportunity for process improvements and productivity gains for the structural engineer struggling to justify the expense of BIM implementation.

Another issue which inhibits interoperability is version compatibility. New features are regularly incorporated into both A&D and BIM software, resulting in software upgrades on a seemingly continual basis. Particularly when the method of linking A&D software with BIM software is via an API, the link between last year's version of your A&D software (that interfaced reasonably well with last year's version of your BIM software) may not work at all with this year's version. And even if you upgrade both your A&D and BIM software faithfully, the API that links the two new versions may not be developed until well after the version upgrades have been implemented.

Another version compatibility issue may occur on long-term projects with numerous collaborators. If all the collaborators are not updating their software on a regular basis, those collaborators using obsolete software will likely be unable to read data created in newer versions. A common solution is for all collaborators to use the same version of their BIM software throughout the duration of a project. The result is that design firms will usually have more than one version of their BIM software, along with the compatible version of their A&D software, coexisting within their office. This is obviously not an ideal situation from an IT standpoint or from a training perspective.

Archiving projects is an even more serious concern. Backward compatibility may prove viable over several software version upgrades, but what is the likelihood that the BIM database will remain accessible to future generations of software over the life of the structure? Anyone with a basement full of LP's, a broken turntable and an iPod will feel this pain.

The Future of BIM and Interoperability

Despite current issues with interoperability, there is much to recommend a BIM-based work process. For the many structural engineering firms currently using BIM, maintaining leading edge technical capabilities, realizing process improvements, improving document coordination, and enhancing project opportunities are ample justification for using BIM. Interoperability, even in its current limited form, results in some degree of process improvement.

But interoperability issues will continue to limit users' ability to freely exchange data between software packages. Current means of achieving interoperability consist of a mixed bag of proprietary alliances and industry standards still in development. True interoperability is dependent on the further development of a robust industry standard, and software vendors' incorporation of this standard into their products.

Interoperability may affect the pace of the transformation to BIM, but not its inevitability.▪

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Feedback

Many firms are using BIM, but how many are actually integrating their A&D and BIM models? Please forward any experiences you have had in integrating A&D and BIM modeling to the author at the email address noted above. Your input may provide useful feedback to be shared in a subsequent issue of STRUCTURE magazine.