Transforming the Delivery Process Using Building Information Modeling

By James G. Jacobi, P.E.

The AEC industry is currently experiencing a rapidly growing interest in a new and improved approach to project delivery, often referred to as Building Information Modeling (BIM). Following is the second in a series about BIM and its impact on structural engineering.

Part 1, titled "Building Information Modeling – a Structural Engineering Perspective", appeared in the September 2006 issue (page 38). To read this article please visit STRUCTURE® magazine on-line at:

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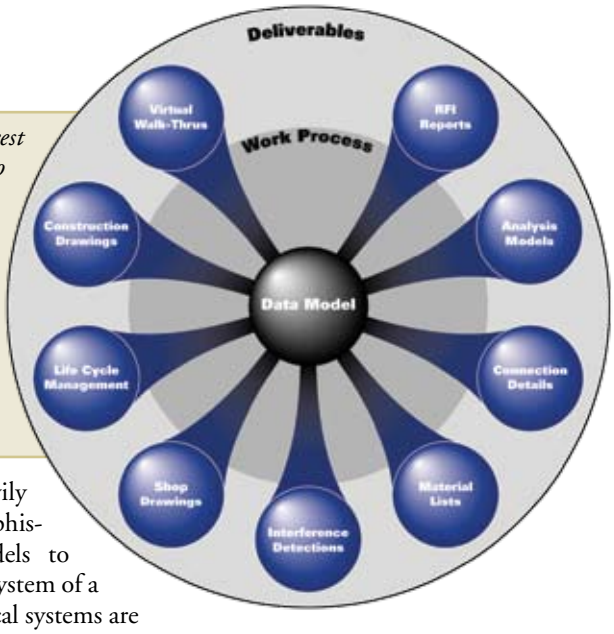


Consistent Data Model Drives Deliverables. ©Walter P Moore

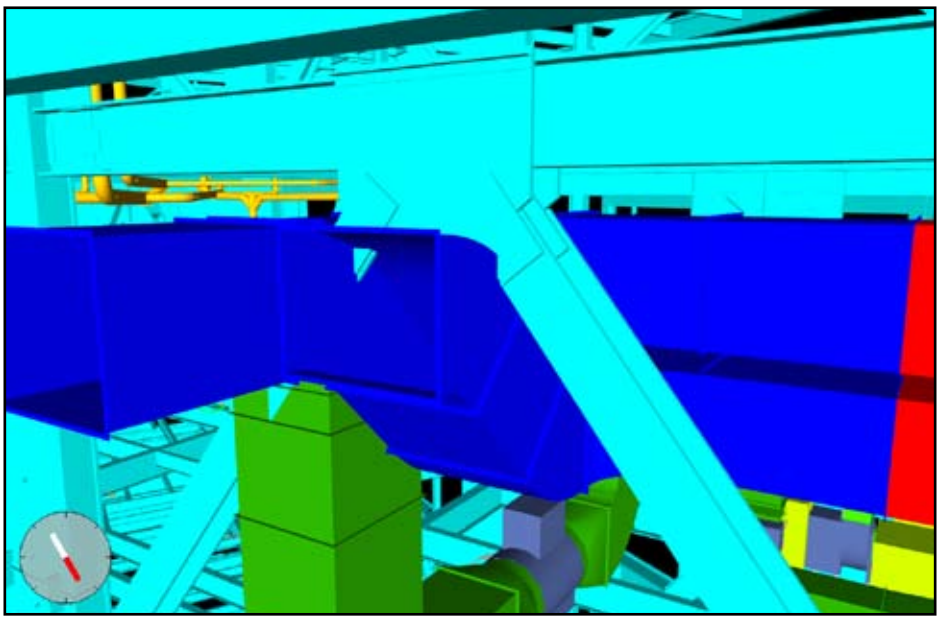
The complexity and rapid-paced development of today's projects are challenging the industry to find new, innovative approaches to project delivery. Building Information Modeling (BIM) is emerging as a high-tech, process transformational method to address some of these challenges. The BIM methodology enables owners, consultants and contractors to visualize and understand evolving designs and collaboration issues as never before. These information-packed digital assets are transforming the way supply chain partners work together to improve the design and construction process by enabling early identification and removal of problems. This is resulting in cost and schedule benefits, and assisting fast track projects to avoid costly delays. In addition to the benefits to design and construction, the digital assets associated with the BIM offer potential to improve the facility management and operations processes long after occupancy begins.

As interest continues to grow in BIM among engineers, architects and contractors, a lot of attention has been focused on BIM-based project delivery benefits associated with multi- discipline coordination of designs and identification and elimination of interferences between disciplines. While such coordination is impressive, BIM-based delivery methods have the potential to reach far upstream and downstream in the delivery process. A holistic view of BIM will surface many other interesting value propositions.

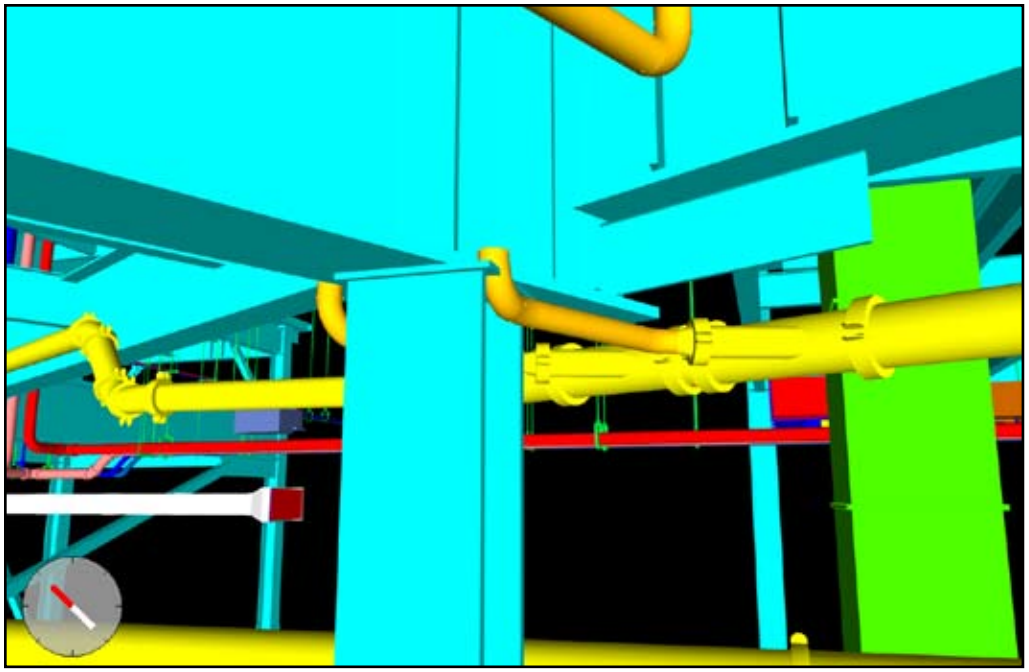
Consider the structural engineer's perspective. Our traditional approach to design has relied heavily on the generation of sophisticated analytical models to describe the structural system of a building. These analytical systems are transformed into drawings for distribution to the project supply chain. Since these drawings and analytical models are not linked, much time and effort are normally required to ensure that changes to the analytical model are consistently reflected on the drawings, and visa versa. This disconnect is legendary for its contribution to errors and omissions on today's primary work product, namely 2D drawings.

As a data-centric process, the BIM-based delivery approach employs a consistent digital representation of the structural model. This data model is then used to generate the required drawings. Drawings are extracted directly from the BIM and then annotated to suit any particular requirements. The production of these documents is not produced independently of the model so they are, in effect, linked. As such, member sizes, dimensions and other details reflect exactly what is modeled. The potential for error and omission is reduced.

A similar linking between the BIM and the analytical model could be used to strengthen the integrity of that process as well. In addition to improvements in



Mechanical equipment clashes with connection detail. ©Walter P Moore



Pipe interference with column cap plate. ©Walter P Moore

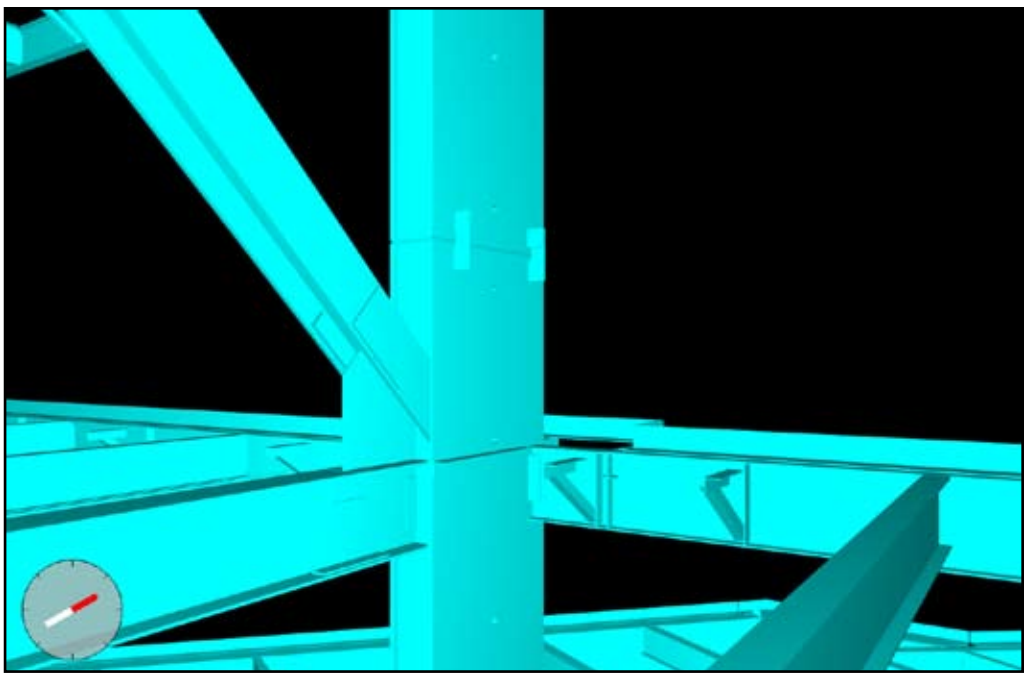
data integrity, such a link would introduce efficiencies into the analysis and design process. For these reasons, it is important that robust links between analytical software packages and BIM platforms be established. Today, this is an area that needs attention and focus by software manufacturers. While interfaces are improving, they are not where we need them to be with respect to simplicity and robustness. Nevertheless, while there is still progress to be made on this front, our experience indicates that the benefits to the project team associated with having a structural model available for design review provide a compelling argument to deliver using the BIM methodology.

These new relationships between data and drawings, data and analysis, can and should be used to reduce errors, in consistencies and uncertainty in the drawings that are produced by the structural engineer to inform the rest of the project supply chain. This is a very significant point when you consider that each discipline on a project has a similar challenge when working with their traditional document centric approach to design.

Unlike the drawing-centric approach used by the traditional delivery process, BIM project participants are able to access the various digital models throughout the process without having to wait until paper drawings are produced and delivered. This means that a multi-discipline view of the project can be shared with all participants early in the process, and continuously throughout design and construction. Experience shows that collaborating in this fashion produces great results that are not possible by using drawings alone. Higher-order collaboration among project participants, better understanding of the design through visualization, and the ability to introduce real time decision making into the design process are immediate and impressive benefits the BIM approach will bring to any project. These two factors alone can result in a substantial reduction in RFIs and field rework which, in turn, will lead to improvements in project schedule and cost reliability.

The old cliché "a picture is worth a thousand words" rings true as new high-tech design review sessions are orchestrated around the digital models. When architecture, structure, civil, and mechanical elements are all brought together in one environment, the design team has the ability to innovate more effectively. Issues that used to become known only in the field are now addressed early in design, where change and improvement can be cost effectively administered. The potential of such collaboration to detect interferences between discipline components before drawings are even produced and shared is impressive indeed.

The structural model plays a central role in this process. The most effective digital review sessions occur when the structural, architectural and mechanical models are available for combination into a single virtual model. The fewer disciplines that participate, the less effective the collaboration effort. When completed properly, this process provides breakthrough results through early detection, reducing problems and issues discovered in the field at the most expensive possible point for remediation. While this digital design review process is robust, it is important to note that it does not replace the traditional quality control processes used by the project and participating consultants and contractors.



Steel model completed with gusst plates and stiffeners. ©Walter P Moore

Where possible, during the design phase, the contractor should participate in the digital review process to help improve the design's overall constructability. Such participation will prove valuable in evolving the design BIM models into relevant construction models to be used later by the contractor. Use of BIM on the project will permit the development of 4D models which incorporate the elements of time and schedule into the existing 3D BIM models. These 4D models will expand the value of the 3D models and project scheduling systems by improving understanding and collaboration for all project participants. Some of the key attributes associated with these models will improve site planning by enabling "what if" scenarios to test and improve plans. Simulations of installation conflicts, design clashes and workflow management can be performed before work begins on site. Construction sequences can be simulated for quick and effective decision making by the contractor, design team and owner. Schedule sequences can be performed continuously for an overview, or stepped through to show the project at particular points in time, linked to actual project construction schedules. Often times these simulations can greatly assist communication and understanding of the construction process for project stakeholders.

Since the underlying models in a BIM-delivered project are digital in nature, each component in the model can contain a rich association of data about its own attributes such as size, weight, material properties, cost, specifications, assembly diagrams, maintenance procedures and schedules, etc. Use of BIM can provide the ground work for the creation of a facility management model for the owner's use downstream. The facility management model can be derived from the design models provided by the project's consultants.The attributes of such a model will evolve as a subset of information useful to the facility management or operations group. Early identification of the facility management requirements will also assist in the development of specifications and requirements for the design models.

When viewed holistically, it is obvious that BIM-based project delivery offers many potential advantages. To capitalize on these, it is necessary to deploy the BIM approach early in the project, get the major consultants and contractor on board and ensure that the contract documents and BIM project objectives are clearly defined and understood. As interest in the delivery process continues to grow, projects that utilize this approach will continue to benefit.▪

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