

## BIM: A Collaborative Approach to Construction

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At the end of a construction project, owners are accustomed to receiving a final set of drawings and specifications from the architect or contractor along with volumes of operation manuals and warranty documents. But what if those drawings, specifications and manuals were fully interactive? What if your drawings could alert you as to when it was time to replace a valve, and then provide you with the model, part number and supplier of the valve?

In a world where iPhone apps, text messaging and tweets allow for instantaneous communication and collaboration, the same is now available in the construction industry. Welcome to Building Information Modeling (or BIM for short).

### What is BIM?

BIM is not a software package. Although it is software driven, it is a dynamic standard whereby different trades and user groups generate and aggregate information for a facility. The National Institute of Building Sciences' *Journal of Building Information Modeling* defines BIM as:

[A] digital representation of the physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward. A basic premise of the model is collaboration by different stakeholders at different phases of the life-cycle of a facility to insert, extract, update or modify information in the modeling process to support and reflect the roles of that stakeholder.

### What is BIM Used For?

BIM can be used throughout the planning, design, construction and operation of a building. During the planning and design of a building, it is common for the project architect to subcontract certain aspects of the design. For example, an architect may hire separate firms to design the structural, mechanical, electrical and plumbing systems within a building. Those separate design firms then produce separate designs using separate software systems. BIM technologies now allow those separate designs (called "models") to be viewed together in a three-dimensional display. Contractors can then upload more detailed information into the models as the construction project progresses.

### BIM During Design

Designers can use the three-dimensional displays to view the interplay between the designs for constructability reviews and also to perform what is known as clash detections. Clash detections are when designers look for places where two trades intersect in a building. For example, the three-dimensional model may reveal an electrical conduit intersecting a beam. The designers can then re-design and/or relocate the conduit and beam to avoid the "clash." Clash detections represent one of the great benefits of the BIM system. The discovery of a clash in the field during construction can oftentimes result in costly change orders and delays as the problem is investigated and resolved. Discovery of the same issue during design averts such costs and delays as the issue can be resolved before the contractors begin construction.

Depending on the level of detail included in the model, BIM models can also be used during the planning phases of the project to perform scheduling and estimating.

### **BIM During Construction**

BIM can also be used during the construction phase of a project. Because the BIM model readily shows the interplay between the different trades (e.g. structural, electrical, plumbing work), contractors can use the BIM model to prefabricate certain portions of the project offsite, which results in greater efficiency and quality control. For example, a contractor building a high-rise structure that has a repeating design on many floors can construct entire wall sections — complete with electrical wiring, HVAC duct penetrations and plumbing rough-ins — off-site in a warehouse location. Because a portion of the project is now being built indoors, it is not subject to adverse weather or interference from other trades and the quality can be more closely monitored. Once complete, those wall sections can then be brought on-site and installed by smaller construction crews. The end result is better quality and shorter construction durations.

Contractors can also load project-specific information into the BIM model for the benefit of the owner. During construction, contractors are typically required to give submittals to the architect that contain detailed information on the specific materials that are going to be incorporated into the project. This submittal information can then be uploaded into the BIM model. Likewise, contractor shop drawings and as-built drawings that show the exact location and size of materials as they were installed into the project can also be loaded into the BIM model. The end result is a three-dimensional model that contains detailed part information for all of the materials used on the job site.

### **BIM After Construction**

Some owners are now beginning to use BIM technologies in their facility management process. To the extent that the BIM model was loaded with product information during construction, owners can then use that information to track the locations of certain materials that were installed in the building and even determine when those parts and materials need to be serviced or replaced.

### **Not All BIM is Created Equal**

Owners can request as much or as little detail in their BIM models as they see fit. For this reason, BIM has been categorized into five levels — called Levels of Development or “LOD” for short — with each LOD containing increasingly more detail. The five LOD’s are summarized as follows:

- LOD 100 – this is equivalent to a conceptual design and contains overall building massing information such as the height, area, volume, location and orientation of the building.
- LOD 200 – this is equivalent to a schematic design and contains generalized systems to be used in the building along with approximate quantities, sizes, shapes and measurements of the building.
- LOD 300 – this is equivalent to construction drawings and contains specific assemblies, quantities, sizes and shapes; LOD 300 BIM models are used for clash detection.
- LOD 400 – this is equivalent to shop drawings, which means that specific assemblies are accurate in terms of size, shape, location, quantity and orientation, complete with detailed assembly and fabrication information loaded into the model.
- LOD 500 – this is the highest level of detail in a BIM model and includes “as-constructed” assemblies with actual and accurate information in terms of size, shape, location, quantity and orientation.

### **Legal Issues**

With the use of BIM comes an additional set of risks and responsibilities that must be allocated between the parties. First, owners should communicate their intended use for the BIM models in their contracts with the architect, construction manager and contractors. In particular, the owner should state its expected Level of Development. Thus, for example, if an owner only wants to

use BIM for clash detection, then it should specify a minimum LOD 300 in its contracts. Second, contracts should also designate which party has responsibility for collecting, managing and archiving BIM model data. Finally, because the contractor can now interface with the design and load information into design models, the line between contractors and design professionals is blurred. For this reason, contracts should specify who has access rights to the various BIM models and also define ownership rights of the intellectual property contained in each model.

## **Conclusion**

In the past, parties have often used a silo approach to construction. The mechanical engineer worked separately from the electrical engineer who worked separately from the structural engineer. The contractor worked separately from all of these parties. BIM offers a collaborative approach, bringing the various trades and professions together. The results can be cost-savings and efficiency for the owner. While BIM offers many benefits, it also redefines traditional roles in the construction process. For this reason, contracts should clearly define expectations and the roles and responsibilities of each party.

# Authors

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