TECHNOLOGY

information and updates on the impact of technology on structural engineering

Integrating BIM

How Does BIM Affect Today's Project Work Flow? How Does it Fit into Today's Projects?

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For the past 20 years, the architecture, engineering, and construction (AEC) industry has utilized two-dimensional (2D) computer-aided design (CAD) documentation to define projects. Some advantages of this approach have included standardization, ease of use, and dimension-ability. Everyone has become familiar with 2D CAD, but it has some real disadvantages. A 2D project is difficult to visualize, requires interpretation by others with the potential for misinterpreting the design intent, and replicates a manual drafting process (low-tech), which means that information may be missing, inconsistent, or erroneous. The biggest disadvantages of 2D CAD are the great deal of coordination required and the lack of consistent information within the drawings.

Building Information Modeling (BIM) is widely viewed as the next stage in the development of the AEC industry. Some of the reasons why architects, engineers, and contractors are now using BIM include:

- Improved visualization.
- Improved productivity due to easy retrieval of information.
- Increased coordination of construction documents.
- Embedding and linking of vital information such as vendors for specific materials, location of details, and quantities required for estimation and tendering.
- Increased speed of delivery.
- Reduced costs.
  - o Reduced change orders to verify quantities
  - o Reduced RFI's to save time
  - o Increased automation – reduces errors

BIM & Project Workflow

Traditional projects not using BIM are back-loaded when it comes to staffing and project delivery. A few people work on the project early on when it is in its infancy (pre-design); typically the design architects and engineers are the ones involved during this stage. As the project progresses, more and more people are added to the project, such as production architects, staff architects/engineers, specification writers, etc. Unfortunately, some of the people making early design decisions are not involved later in the project, thus creating a fragmented process.

With BIM, projects are front-loaded, with most of the modeling time occurring early in the schematic design and design development phases. During the construction documents and construction administration phases, the workflow tapers off and is relatively low in terms of modeling. Teams are formed early in the design process and begin collaborating sooner. By using BIM technology, design teams can be pared down. As the team leverages the model, more information is available. By having smaller teams, the people making the decisions early on are involved throughout the entire project, resulting in a better quality product.

However, it is critical that the team be comprised of individuals who know "how buildings go together." With BIM, "you can't fake a project anymore." The model will quickly make any design deficiencies evident to the team. Shortcuts that could be taken with the documents when drafting can no longer be taken in BIM.

With this great efficiency and amount of information available have come some unrealistic expectations from owners and other team members on the level of accuracy and detail of the model. The industry today does not have well-developed standards for BIM, like the ones that exist for traditional 2D CAD. This has put architects and engineers at risk.

In 2008, AIA released document E-202 that defines the roles and responsibilities of the various team members using BIM, and specifies the required level of detail of the model at each stage of the project. Each firm should develop its own BIM execution plan based on the levels of detail from the E-202.

Such a plan might also include a detailed Model Definition worksheet that correlates the levels of detail with what one would expect to see in the actual models. This worksheet essentially removes the guesswork for the project team as to what is expected in the model as the project moves forward. For example, an architect knows the level of information to provide for a door at schematic design, design development and in construction documents. This way one is not over-modeling early in the design process, and under-modeling or missing information when the drawings are ready to go out for bids.

Simultaneously, firms can develop a BIM process timeline to assist the design team in assembling models. This timeline, unlike a project schedule, shows the progression of a model–what needs to be modeled first, second, etc. Conflicts are eliminated as the team knows when to model things and the order in which they need to placed in the model. For instance, walls need to be modeled before ceilings, rooms, or doors. Ceilings need to be modeled before the electrical engineer can come along and layout lights. This timeline proves beneficial to project managers when they are scheduling team workload, and it also gives them a clear understanding of how the work is to be done in assembling the model in their project. This also helps clients have a better understanding of what to expect when they receive a BIM model.

Figure 1 is a project completed by KAI in 2009. The architects and engineers worked in conjunction with construction professionals to produce a coordinated design model for

the Cambridge Heights Senior Housing project. The team was able to model each individual dwelling unit, thus providing the quantities needed during the bidding process and construction. By modeling the units, the team was able to find problem areas with the design and conflicts between the building systems prior to construction. The team also ran clash detection between the various building systems.

BIM & Collaboration

With BIM representing a model-centric collaborative approach at its core, the building industry and individual companies are trying to develop new ways of working together. Models are now developed with the owner, design team, construction team, and others all contributing. This method led to the formation of the Integrated Project Delivery (IPD) approach.

AIA explains various aspects of IPD as including: 1) team collaboration and communication; 2) roles, responsibilities, and service scope; 3) measuring project goals; and 4) risk assessment and contracts. IPD is envisioned as a specific type of project delivery method, which is intended to leverage the capabilities of BIM tools. One could argue that IPD is in response to emerging BIM technologies coupled with blatant inefficiencies of traditional project workflows and design tools. If one were to compare traditional projects to IPD projects, it might look something like this:

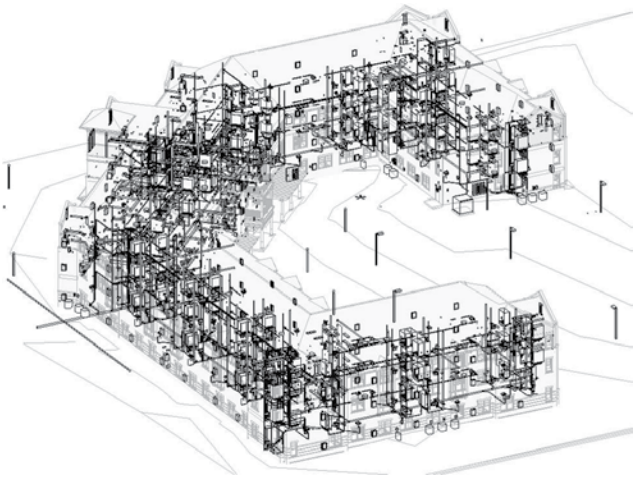

Figure 1: Image is of Cambridge Heights Senior Building, St. Louis, MO a project done by KAI Design & Build in 2009.

Traditional Project Delivery

- Teams are fragmented; assembled on an "as-needed" basis; strongly hierarchical
- The process is linear/distinct/segregated
- The risk is individually managed; transferred to greatest extent possible
- The reward is individually pursued; minimum effort for maximum returns
- Paper-based; 2D deliverables
- Agreements are a unilateral effort; allocate and transfer risk; no sharing

Integrated Project Delivery

- Teams are composed of key project stakeholders; assembled early in process; open, collaborative
- The process incorporates early contributions of knowledge; information openly shared; trust; respect
- The risk is collectively managed; appropriately shared

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- The reward is team success tied to project success; value-based
- Digitally-based; virtual; BIM deliverables
- Agreements are encouraged; fostered; teams are to promote and support multi-lateral open-sharing and collaboration; risk sharing

Build Before You Build℠

BIM has opened an opportunity for designers to assist contractors. Though not quite IPD, KAI has developed a new service offering for contractors: ***Build Before You Build℠*** (BBYB). KAI saw the value of involving the contractor early on in order to leverage the integrated value BIM offers. On one BBYB project, a general contractor client commented, "1 hour of BIM saves 10 hours in the field." Contractors understand the cost savings that BIM can bring them during construction.

The new BBYB service uses a multi-tiered approach. The BBYB team takes the design team's bid documents and builds a coordinated 3D model to assist the contractor during construction. The client can choose from the following levels of service:

Level 1 – Offers a generic build-ability review of the project at a very high level of coordination of the bid documents.
Level 2 – Explores the documents more in-depth; a more detailed build-ability coordination is done.
Level 3 – MEP systems are incorporated into the model; this offers a cross-discipline check of the model and a more precise level of coordination.
Level 4 – Spatial coordination and collision detection are done in the model.
Level 5 – Scheduling and takeoffs are performed in the model.
Level 6 – Phasing and mobilization studies are performed.
Level 7 – Visualization and animation are performed.
Level 8 – Lifecycle and facility management are included.

The BBYB team typically meets with the contractor and subcontractors on a regular basis during the construction process (*Figure 2*). Coordination meetings are set up with the team, with the model on the screen so that the team can make adjustments to the work to resolve conflicts that have come up from the previous meeting. Typically, subcontractors provide the BBYB team with weekly updates of their models. Once the collision checks have been done, the BBYB team sends a report to the construction team so that they can update their own models. This process has greatly helped subcontractors that are just now getting into BIM to avoid costly changes and problems once they are on the jobsite.

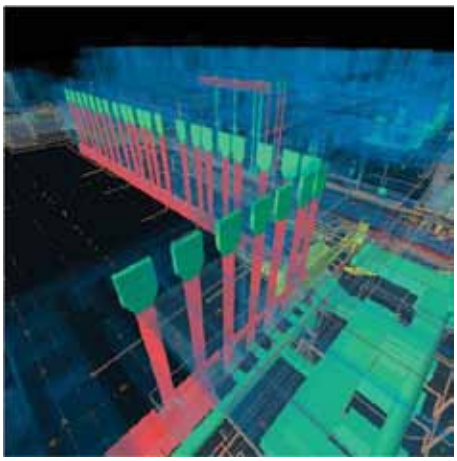

Figure 2: St. Louis Art Museum Coordination Model KAI Design & Build, under construction

KAI is providing BBYB services on the current St. Louis Art Museum renovation project, doing model management during construction. Subcontractors were required to provide BIM models to the general contractor and to KAI. KAI then took these models and integrated them into a coordination model; collision checks were performed between all the systems and the architectural/structural models at set intervals during the construction process. The contractor and the subs were then able to meet and review these collisions, and resolve them prior to the commencement of work in a given area. Ultimately, both the owner and the contractor have benefited, as many conflicts have been avoided, saving all parties involved both time and money.

Conclusion

BIM is affecting many facets of the AEC industry. Design teams now understand the tremendous value that BIM and 3D design tools offer them. Owners and contractors are becoming more educated about the possible benefits of BIM and are requesting architects and engineers to create models that they can use in their projects. It is safe to say that BIM is here to stay, and companies that do not embrace it run the risk of being left behind.▪