3pAAb6. Building information modeling (BIM) and the consultant: Managing roles and risk in an evolving design and construction process

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Paramount changes are occurring within the building and construction industries, fueled by the ever expanding abilities of computer modeling technologies. This revolution not only impacts our approach to and execution of the physical design of a building, but also the construction and the day to day management of the facilities. Current technologies have allowed the Building Information Modeling (BIM) process to replace many of the time tested design methods of the past. With this shift to new technologies also come new risks which require recognition by the acoustical consultant to ensure our evolution to meet the new paradigm of the current design environment. In this paper the importance of understanding the purpose and role of a BIM implementation/execution plan will be covered inclusive of defining the role, responsibilities and risks associated with the acoustical consultant.
INTRODUCTION

Building information modeling or “BIM” brings with it many advantages for the digital design of buildings. With this advance, many architecture and engineering firms use BIM software applications increasingly in the design process along with construction firms throughout the construction process. Additionally, building owners create BIM models for existing facilities both for internal use and to aid future tenants, facilities managers, and designers in planning for maintenance programs, restoration, or renovation. These tools provide powerful opportunities to the acoustics community. The primary benefits to architectural acoustics consultants fall into two broad categories: first, in the construction process by providing a means of organizing the specifications for materials and constructions, and second, in the design process, by establishing a framework of data and acoustical attributes that in the future could potentially aid in acoustical calculation and analysis. BIM is making things possible that were never possible before for designers and engineers. Enhanced usage of electronic design and construction processes holds promises for saving time and money, reducing claims and increasing the quality of performance, especially on complex projects. However, design and construction professionals need to both recognize and consider the issues and risks associated with this new process.

BIM is a paradigm shift and has changed the way industry thinks about how technology can be applied to design, construction, and management of building projects. Building information modeling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of a facility. The resulting building information models become shared knowledge resources to support decision-making about a facility from earliest conceptual stages, through design and construction, through its operational life and eventual demolition. It is an integrated database of coordinated information to which many participants in the design and construction process contribute. BIM modeling provides for continuous and immediate analysis of project design, scope, schedule, cost information and more. Those who favor BIM have identified many of its benefits as:

- higher quality of work performance
- better coordination among design and engineering disciplines
- costs savings in the design and engineering work
- and increased speed of delivery

Supporters of BIM technology indicate that the globalization of large projects is forcing increased efficiency. BIM provides new means of collaboration including advanced design build models and more sophisticated use of internet project management. At the forefront of this movement, it is viewed by many as an important tool of change and competitive advantage for design professionals.

BIM AND MULTIPLE DIMENSIONS

What does BIM do? It enhances the collaborative process of design and engineering. It provides an integrated database of coordinated information among the contributors to the design and engineering of the building. In addition to graphically depicting the project, BIM offers key information about the building that can be used to analyze its performance. The use of coordinated, consistent, computable information results in a reliable, digital representation of the building that can be used during the design process, production of contract documents, planning and building performance. BIM allows information to be kept up to date and accessible to architects, engineers, contractors, owners and others.

BIM is different than CAD. Those who are critical of CAD design mention its tedious and time consuming process; missing, erroneous or inconsistent information that can be maintained on design documents; the difficulty of collaboration among design and engineering professionals; and the important fact that conflicts detected during construction are often expensive to address. BIM avoids the problems of CAD because it does not design solely on geometric concepts. Further, it adopts the relationship between all building components. The building information model is viewed not only in two or three dimensional views, but even greater (4D, 5D, 6D…) which enhances the elimination of inconsistent design or engineering concepts.

The concept of multidimensional building information modeling may be difficult to some. Yet the key part is to understand what additional information you are adding to the project to give it that additional dimension. Basic BIM, 3-dimensional, can be amended to incorporate time (4D) and cost (5D) aspects of the building’s virtual model. Additionally, the aspects of life-cycle facility management can be included in the model to incorporate a sixth dimension (6D).
4D BIM refers to the intelligent linking of individual 3D CAD components or assemblies with time- or schedule-related information. The use of the term 4D is intended to refer to the fourth dimension: time, i.e. 4D is 3D + schedule (time). The construction of the 4D models enables the various participants (from designers, contractors to owners) of a construction project, to visualize the entire duration of a series of events and display the progression of construction activities over time. This BIM-centric project management technique vastly improves the project management and delivery of construction project of any size or complexity.

5D BIM refers to the intelligent linking of the 3D BIM with cost-related information. The use of the term 5D is intended to refer to the addition of fifth dimension: cost to the 3D model, i.e. 5D is 3D + cost. The addition of cost can be done independently from the addition of time. However as time and money are inevitably linked, many consider 5D BIM to be the addition of the cost dimension to the 4D BIM dimensions of length, width, height and time. The construction of the 5D models enables the visualization of the progression of construction activities and their related costs over time. As compared to 4D BIM, the addition of the cost dimension provides the project manager with an improved understanding of the available options in managing the project and helping to reduce costs and time.

6D BIM refers to the intelligent linking of the 3D BIM with all aspects of project life-cycle management information. The 6D model is usually delivered to the owner, when a construction project is ready to be closed-out. The “As-Built” BIM model is populated with all relevant building component information such as product data and details, maintenance/operation manuals, cut sheet specifications, photos, warranty data, web links to product online sources, manufacturer information and contacts, etc. This information-centric database is made globally accessible to the users/owners through a customized proprietary secure web-based environment. The accuracy of 6D BIM aids facilities managers in the operation and maintenance of the facility throughout its life cycle. The 6D BIM can be done independently of the 4D BIM and 5D BIM processes.

Previously CAD altered the design landscape. Now BIM is seen as having an even greater impact. The General Services Administration of the United States Government now requires that all firms providing services to it have to include a Building Information Model as part of their design services and deliverables. But with the speed at which this changes to the design and construction industry are occurring comes risk. As the relationships among the contributors to a BIM design project are established, the boundaries of their responsibility and work product become blurred. How do we allocate risk as a result? In the CAD days, it was easy to determine the contributions of the designer, engineers, contractors and others. In a BIM process, this is not as easily determined. Should risk be shared? Should a means be in place to track the contributions of all participants in a BIM project in order to determine who made a decision, who is responsible or where risk should be assigned?

**MANAGING RISK IN BIM**

Some proponents argue that shared rewards require shared risk, while others argue the need for compartmentalized liability and risk between project contributors. Who is liable for errors, mistakes, omissions or other problems that arise on the BIM project? Will we be able to tell who contributed specific tasks? On one hand, common sense may apply and yet on the other hand, the integrated concept of BIM blurs the levels of responsibility so much that risk and liability will likely be enhanced. Does implementing a BIM project require a “one for all and all for one” approach to project risk management? Possibly, though additional concerns exist with BIM. From the practical, such as the steep learning curve for employees to the fact that the more advanced BIM users appear to be younger architects/engineers/project managers who often lack the needed professional experience. Additionally the need for everyone to be working on a project in one BIM system creates concerns that must be considered.

To successfully implement BIM, a project team must perform detailed and comprehensive planning. A well-documented BIM Project Execution Plan or BIM Implementation Plan will help to ensure that all parties are clearly aware of the opportunities and responsibilities associated with the incorporation of BIM into the project workflow. The BIM Execution Plan (BEP) is one of the most important elements of any successful BIM project. This plan defines the overall approach to BIM on a per phase basis including objectives for construction and operations of the facility as well as local governing standards and requirements. A completed BIM Project Execution Plan should define the appropriate uses for BIM on a project (e.g., design authoring, design review, and 3D coordination), along with a detailed design and documentation of the process for executing BIM throughout a facility’s lifecycle. Once the plan is created, the team can follow and monitor their progress against this plan to gain the maximum benefits from BIM implementation.
REDUCE YOUR RISK WITH PROPER IMPLEMENTATION

When the decision is made to implement BIM, consideration must be given to the training required. While individual staff research is important, a focused plan on the firm wide training effort is mandatory. This can be challenging, as the development of this plan affects all aspects of the project production. Managers will need to be trained to understand software capabilities, technicians will need to be trained in the efficient use of the software, and engineering staff will often times be caught in the middle between the production issues of the technicians and the grand vision of the managers and marketing personnel. Managing expectations is critical to making sure this process is implemented at the right pace.

Organizations will often go through the following experiences during the integration of BIM into their production process:

- Cautious investigation
- Trial and Error on a small level
- Recognition of value
- The big sale on the big project... then reality strikes
- Implementation of standards
- BIM efficiency

The order of these events may vary from organization to organization, but BIM efficiency is likely never to come before the implementation and transition of corporate standards. This process needs to be considered and worked into the plan. While time consuming, it will aid in transitioning your organization from the 2D world into an efficient 3D BIM practice. Another issue that organizations will grapple with is the quality of the product. A concerted effort and investment can be required to get the new software to produce drawings that appear the same as your old deliverables. Sometimes it is wise to consider alternatives in the product output. It may be less time consuming to consider a change in the standard output and tailor it to what the software can do, rather than implement the strict performance guidelines developed during the CAD era.

The goal for developing this structured procedure is to stimulate planning and direct communication by the project team during the early phases of a project. The team leading the planning process should include members from all the organizations with a significant role in the project. Since there is no single best method for BIM implementation on every project, each team must effectively design a tailored execution strategy by understanding the project goals, the project characteristics, and the capabilities of the team members.

CONCLUSION

Many limitations still exist for the consultant trying to implement BIM into their projects. However these limitations are slowly going away as better communication, transferability and integration between architectural/engineering design platforms and acoustical modeling/analysis programs are being developed. While the risks are high and errors may (and will) occur during the learning process, adopting BIM into your project workflow and integrating it into your design standards will enable acoustical consultants to better integrate our work into the overall project and be an integral part of the paradigm shift occurring within the AEC industry.

REFERENCES AND LINKS


