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▶ TECHNOLOGY

Integrated Design, New Software Changing the Face of Architecture

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The architectural profession is on the cusp of a major change in how it designs, draws and documents its work, as well as how it interacts with other members of a design and construction team. The catalyst for this change is Building Information Modeling technology, more frequently known by its acronym BIM. This software represents a fundamental shift in the way that architectural work is done.

The significance of this change lies in the long-used design technology CAD, or Computer-Aided Design. CAD enables designs to be created in a digital atmosphere, and can be used to draw anything from an airplane, to a car, to a building. Over the years, various CAD software companies have offered ways to customize their packages for specific disciplines. A CAD package that is customized for architecture is tailored to draw objects, not lines. For example, a door can be placed in a drawing by selecting a specific door object by its attributes (height, width, materials, etc.). All objects in the drawing—such as doors, walls, furniture, windows—can be viewed in three dimensions.

BIM takes this process one step further. While CAD allows designers to pick and place three-dimensional objects, this drawing process occurs on a two-dimensional floor plan. In CAD, if a designer wants to draw a building that is a cube, he would create multiple floors in individual drawings. BIM is not floor plan-oriented. Using BIM, a cube is drawn in three dimensions, with walls that extend the full height of the cube. To create floor plans from the cube, the designer simply indicates where he wants the floor plates placed within the cube. Because the complete building block was created, exterior elevations are automatically set up and ready for exterior objects (windows, doors, curtain walls) or interior features to be added.

By creating a model in BIM, a designer is creating a database of information from which reports can be extracted. In this system, the reports are drawing sheets. Depending on the drawing sheet type (plan, section, elevation), certain information is filtered in while other information is filtered out. When elements are added to a design, information is added to the database.

Those who sell BIM software claim that it will significantly reduce errors and omissions that can occur in traditional construction documents. This is likely true, but the real promise of BIM goes much further. There is no limit to the level of information that can be built into a BIM database. When a window is created, it has inherent data about its size and materials, and also its energy retention characteristics and much more. With all of this information in place for all of the materials on the building exterior, architects can conduct dynamic heat loss calculations directly from the database. This is known as "prototyping".

Architects have often chafed when building design and construction is compared unfavorably to manufacturing. When you buy a car, it has been prototype-tested, refined, and tested again and again. In contrast, a building is built only once; not all of the errors can be resolved ahead of time. Many times, problems get worked out in the field, when the labor costs for lost time are at their extreme. BIM allows architects to create a digital prototype, and then audit that prototype for performance and for constructability. The result is that more issues can be resolved during the design phase, because they can be seen and demonstrated during the design phase, resulting in savings in time and capital.

Even the simplest project typically employs design work from professionals in multiple disciplines, such as HVAC, plumbing and electrical engineers, and structural engineers. BIM allows all of these elements to be viewed at the same time to resolve potential conflicts (ex. steel

beams intersecting with duct work) before construction begins.

Opening up new ways for all members of a design and construction team to work together, BIM is part of what many in our profession are calling "integrated design". In addition to physical data about an object, such as a door, a BIM model can be shared with a project general contractor and/or construction manager to obtain cost and ordering information from a door and frame subcontractor. In response, the subcontractor adds information to the model about the cost of each door, model number, and other information needed to purchase or fabricate the door. The general contractor and/or construction manager uses that information, along with the cost and ordering information supplied by other subcontractors for all of the materials used on the project, to create a complete cost estimate and analyze key long lead items.

The BIM approach integrates information from all members of a design and construction team. The information all resides in a single database (the BIM model), and as a result is better coordinated internally. There are risks to this approach, and many architects and general contractors worry that this can mean a blurring of the traditional lines of responsibility. The American Institute of Architects (AIA) is actively studying a contract type that would bind all parties (owner, architect, general contractor, subcontractors, etc.) to a project entity, in place of a typical contract environment where an architect has contractual obligations to the owner, as does the general contractor.

According to the Eighth Annual Construction Management Association of America (CMAA)/FMI Survey of Owners, more than a third of construction project and program owners say they have used BIM on one or more projects, and BIM usage grew by 11 percent in 2006.

BIM has great promise to change the way we think about the design and creation of new buildings and spaces, and to drastically improve the way those kinds of services are delivered. Looking forward, BIM and integrated design will continue to revolutionize the building design and construction industry. ■

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