BIM

Building Intelligent Models
For
Better Information Management

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Many people, from various design disciplines, call CAD Masters everyday regarding BIM. What is BIM? Why is BIM so important? Is BIM only related to building design? These questions are very direct; however, I often receive calls that are not so clear. For example, I have had people call me that have expressed an interest in buying BIM. It is easy to become confused or be mislead by the sea of advertisements, slogans, and mandates; hence, my reason for writing this paper. The objective of this document is to explain the often ambiguous topic of BIM and how it can be used to improve your current design workflow.

Before I begin explaining the enigmatic features of BIM, I would like to dispel a couple common myths. First and foremost, BIM is not software; moreover, you cannot purchase BIM. There are several CAD software packages, like Revit, that help designers achieve a BIM design, so you could conclude that some software is more BIM-capable than others. Secondly, BIM is not just for building design. The original definition of BIM may have applied solely to building models, but this concept of smart modeling is permeating out to other disciplines. There is not an equivalent acronym to describe civil models, landscape models, and mechanical models, so many people use BIM concepts to describe non building models. I believe the concepts discussed below can be applied to almost any field of design, but for conciseness, this paper will focus on the architecture discipline. To speak a little more intelligently about the topic we should start with some definitions.

BIM is minimally an acronym for Building Information Modeling. Wikipedia defines Building Information Modeling as a process of generating and managing building data during its life cycle. My interpretive definition of BIM is a design workflow that produces more intelligent models. These two definitions are very similar and encompass the same underlying idea; Building Information Modeling produces CAD models that have a wealth of information like spatial information, geographic information and building information. If you design anything in 3D using real-world coordinates and attach additional information to objects in the model, then you are utilizing BIM. The following paragraphs will thoroughly explain the major aspects of BIM and how they apply to better building design.

3D modeling

Some may argue that BIM has nothing to do with 3D modeling, but I disagree. For this paper, spatial information will refer to building geometry and proximity information. For example, the height of a wall or the distance between furniture is spatial information. 3D design is an integral part of Building Information Modeling because it allows for easy extraction of any spatial information from a CAD drawing. A 2D drawing may be able to show you the proximity of objects in plan view, but what about the heights and depths of everything? Why is spatial information so important? A 3D model is useful in reducing design flaws, identifying coordination errors, and facilitating better communication.

3D modeling inherently reduces design flaws, because all 2D views of the model are extracted from the same model. Many building designs that are constructed in 2D follow the same process. Every view of the building is designed and drawn separately in independent views (floor plan, elevation, section). When an object is added or modified, it needs to be updated in each view manually. This produces problems because often certain updates may not be propagated to every view accurately. For example, what if an architect looks at his plan and decides to move a wall. First, he moves the wall in the floor plan view, then elevation view, and finally in 2 other section views. Let's say something distracting like a phone call happens and he forgets to update the wall in one other section view. That section view may have shown him that the new location for the wall has a conflict with another object or that some building code is not satisfied. If that error is not caught during the design phase, it may augment into a hefty change order during the construction phase. A similar example would be instead of not moving the wall, what if it was moved a different amount in different views. The same dismal result would arise. Even the most diligent, careful designer makes mistakes sometimes, and oversights are common human errors. These familiar issues are not problems in a 3D design. A typical 3D design scenario encompasses modeling a building in 3D space and slicing through the model to extract individual 2D views. When the model is changed all views are updated with the newest representation of the model. If the architect from the example above used a 3D model, they could review all the sections after his wall was moved and he would quickly see that there was a conflict. 3D modeling is great for reducing design errors and it is also useful in discovering coordination errors with other disciplines.

3D information allows all designers of a building to realistically analyze a design as a whole and improve coordination between disciplines. Before working in the engineering community, I worked in the construction field. Through that experience, I learned the value of coordination between subcontractors and the value of thinking a task through before constructing it. It is not entirely uncommon to overlook little details when designing a whole building or a whole building system. I have seen this many times with regards to ceiling spaces, crawl spaces, and attic spaces. If an architect designs a floor assembly to be 12" deep, there is approximately 10-11 inches of space to run ducting, wires and pipes. If an 8" duct runs through the floor, not much space is left over for elements such as wires, venting pipes, drain pipes, chilled water pipes, and hot water pipes. If these conflicts are detected in the design process then the architect could choose to create a floor space with 14" of space instead of 12" which may resolve some of the issues. Trying to keep track of various consultants' designs and your own is difficult and time consuming. Trying to coordinate in 2D is even tougher because as one part of the design changes, every 2D view needs to be updated manually including consultants drawings. 3D modeling makes this coordination effort much easier, because coordination becomes a visual effort; in fact, if you have the right software, interferences can be detected and shown to you automatically. If all of the design scenarios are coordinated in 3D there is a smaller chance of misrepresenting the design in any 2D view. A 3D coordination effort from all consultants will reduce design based change orders, but what about client change orders?

A 3D model is about the most valuable communication tool there is to describe a building. If pictures are said to be worth a thousand words, then a 3D model is worth millions of words. It is often difficult to show a client or owner a set of 2D construction documents and have them visualize the 3D space. There always seems to be a miscommunication between architects, contractors, and owners. With a 3D model you can sit the client or contractor down in front of a computer monitor and they can walk through the new space. There is no substitute for seeing the completed 3D space because it is often difficult to visualize the color of a room from a paint chip or the look of an entire floor from one tile. I am sure that most contractors and architects have dealt with communication problems with clients. If you ever had to demolish a brand new floor that was halfway constructed or had to redesign a kitchen halfway through construction process because a client changed their mind, you know what I mean. With a 3D environment it is easy to see if the given scenario works for the client or not. This ultimately creates happier clients and reduces construction costs, because all of the design scenarios are done proactively and there are virtually no surprises when construction happens. 3D spatial information is a particularly useful aspect of a BIM model, but to completely design by BIM standards, geographic information cannot be overlooked.

Geographic Information

Geographic information deals with locating and orienting the design in CAD relative to real world coordinates. It sounds simple enough, but this is probably the most neglected aspect of the building design process. Generally, CAD programs use the mathematical Cartesian coordinates (X,Y,Z) to describe a location in space. Most surveyors, engineers, and landscape architects use geographic Cartesian coordinates (N,E,Z) to orient their designs in CAD. I have seldom received a building design that was oriented to real world coordinates. Why? Maybe the better question is why not? Orienting a building to real world coordinates not only helps coordination between consultants but it can create advantages for the architects as well.

Geographic Information is important to anyone who works on the site plan of the structure. The work flow of a typical project may start with the survey of the site and initial topography. The surveyor typically creates the survey from either a benchmark location or some other geospatially referenced point of beginning. That location is typically mapped in a site plan, so that a civil engineer can design the proposed grading plan, roadwork, and any other site-specific design relative to that reference point. The surveyor and civil engineer typically work in the same coordinates, so it is fairly simple to communicate using the same spatial reference frame. When the architect designs the building, it also makes sense for him/her to design in the same space, so coordination goes smoothly. If everyone is designing based on the same geospatial references, then everyone can transfer drawings and coordinate effortlessly. Other benefits can be seen as the project goes into construction because the surveyors can use global positioning to stake features for the grading contractor. The foundation contractor can use global positioning to set building corners. The geographic information associated to a building information model assists the whole team from preliminary design to construction. Even though it seems geographic information may be more useful to contractors and engineers, there are benefits for architects too.

When a building is designed using the actual location in the world, a more accurate site plan can be achieved, leading to a more energy efficient building design. One way to make a building more efficient is to use less energy to heat and cool the various spaces. All structures that reside in the northern hemisphere get more exposure to light from the south. If you are trying to reduce energy spent heating the space in the winter then south facing windows will allow more radiant heat into the structure. If you are trying to keep heat out of the spaces in the summer then roof overhangs can be designed so that during the summer months the windows get exposed to less direct light; therefore keeping the spaces cooler. The orientation of the building on the site is crucial in utilizing this green building method. To aid in the designing process certain CAD software packages like Revit and AutoCAD Architecture, easily perform solar studies based on the geographic location of the structure. Creating a 3D model and utilizing solar studies can definitely make it easier to locate the most efficient placement of a building. In conjunction with geographic location, adding information to a model can help designers build more intelligently.

Building Information

Building information is a powerful tool that can be utilized to make any 3D model more intelligent. Building information is exactly what it sounds like; information that is attached to all components of a building. For example, in a 2D CAD drawing usually 2 lines represent a wall, but those lines do not have any useful information attached to them except for their length. If that same wall was represented by a Revit wall object, that wall would have all sorts of useful information attached such as the fire rating, finish materials, structural usage and cost. This type of environment really gives a designer the power to instantly gather information that would take time to figure out manually. Building information can be used to facilitate better, greener, more sustainable design practices that live on for the life of the building.

Building designers can use building information to take their design beyond their current limits. With information at your fingertips, it becomes much quicker to analyze whether the building was designed as efficiently and as cost-effective as possible. Image you in charge of designing a small 5-story hotel. The property owner envisions the design of a sleek, modern building completely constructed of sustainable materials; however, they have a strict budget and want the work completed at a rock bottom price. How can building information help you conquer this daunting task? For starters, every component in your initial model will have a cost value assigned to it. You would quickly and effortlessly generate a cost chart for the owner and help them keep their bottom line. To make this more challenging, let’s say that the initial cost estimate was a little more than expected. The owner wants to make sure that the building doesn't loose the initial vision for the design; however, the cost needs to be reduced as much as possible. Several design scenarios can be analyzed before the final plans are sent off for bidding. With Building Information Modeling, a brand new cost estimate can be generated per iteration of the design. This helps ensure that as you focus on the aesthetics of the building, the owner can be actively involved in the financing of it. Aside from cost, BIM can also help generate any other information that the designer would deem important to monitor.

A BIM designer can easily assess whether a structure is designed as efficiently as possible from sustainable products with little impact on the environment. The green building movement is a hot topic now and I foresee that it will become an even greater topic as the natural resources that we depend on are consumed. Green building encompasses the following major ideas:

- Minimizing the environmental impact when constructing a building
- Minimizing the waste by utilizing sustainable and recycled products
- Achieving greater efficiency with building resources that need to be used (ex. water, natural gas, electricity,)

You will notice the terms used to define green building are subjective. There is not one answer or approach to achieve a perfectly green building, hence the design process will generally involves a cyclical procedure of design and analysis. In a BIM model, every piece of a building is categorized and all materials are accounted for. When it comes time to analyze the utilization of sustainable materials, a query can be performed on the model and all materials can be scrutinized. If a change needs to be made based on the preliminary findings, then the model is updated and the new analysis begins. There are also many additional analytical applications that import BIM information and use it to evaluate the structural properties or building system properties. Hopefully by now you can easily see the benefits in using BIM during the design phase, but the use for information does not stop after the building is constructed.

When an electronic model of a building has information available for all objects within the building, managing all aspects of the building becomes centralized. Over the course of a project, major concerns about the building tend to transfer between the architect, the owner, and the contractor. When the construction is finally completed all of the burden usually falls back on the owner and the facility management department. With building information modeling, the CAD model can be used for the life of the structure. When modifications are made to the building in the future, the model can serve as the as-built plan. When equipment needs to be moved within the building, the CAD model can be modified and schedules will automatically be updated. A well modeled drawing becomes a deliverable that never loses value.

Final Thoughts

BIM is a designing method that utilizes spatial, geographic, and object information to produce intelligent, information-rich models. BIM could also be considered the next evolutionary step for all designing disciplines. Designers used to draft and coordinate entire projects by hand. Then they moved into 2D computer aided drafting with semi-automated coordination. BIM is the next logical progression of design where the computer is leveraged to improve coordination and create more efficient design scenarios. I invite you to use this paper as a stepping stone towards further education on the subject and related topics. If you have any further questions on BIM, BIM implementation plans, or designing software, please call CAD Masters.