Lachmi Khemlani

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There is a new buzzword in town—"building information modeling". First introduced by Autodesk, the term is also being approved by other CAD vendors like Bentley and Graphisoft to describe the state-of-the-art technologies underlying their products and the new capabilities they offer to building industry professionals. Autodesk has jumpstarted this initiative by hosting a series of events in major cities across the US, designed to educate its customers about the benefits of the building information model approach and present its new technology strategy. I had the opportunity to attend this event in San Francisco recently, on Jan 13, and will devote this issue of the AEC Tech newsletter to a discussion of the building information model concept, in light of the Autodesk event. This topic is of great personal interest to me, as it is closely related to my Ph.D. research at UC Berkeley.

What is a Building Information Model?

A data model in a given domain describes the attributes of the objects in that domain as well as how these objects are related to each other. Since all computer programs deal with some kind of data, they must have some kind of underlying data model. General-purpose CAD programs like AutoCAD and MicroStation deal primarily with geometric entities such as points, lines, planes, etc., so any building drawings you create with them don't carry much information about the building itself and are essentially "dumb" in that respect. General-purpose 3D modeling software such as Autodesk VIZ and form•Z also have geometry-based data models, so even the 3D building models you create with them fall in the same category and are used purely for visualization. Architecture-specific 3D add-ons to generic CAD programs such as Autodesk Architectural Desktop (ADT) and Architecture for MicroStation Triforma fare slightly better in this regard, as they do have an underlying building data model, but this is piggy-backed on to the main geometric data model. Therefore, these programs display limited intelligence when it comes to creating and editing building models, and extracting the relevant building-related information from it that is needed for analysis.

Programs such as Autodesk Revit and ArchiCAD, on the other hand, were developed to model buildings in 3D right from the start, so their underlying data model deals first and foremost with building entities. Geometry is only one of the properties, among others, of these building entities; thus, its primacy is greatly reduced, even though the interface to creating the model is still mainly graphic. Since the data model of these programs focuses on the building objects and their relationships to each other, it is rich in information about the building that can be extracted and used for various purposes, be it documentation, visualization, or analysis. Moreover, a single building object will be described only once in the data model, whether it appears in a plan, elevation, or 3D view. This leads to a model that is always consistent—any change that is made will automatically be reflected in all the views. ArchiCAD refers to their model as the "virtual building"; Autodesk has chosen to call it the "building information model." The names may differ, but the concept is the same.

The concept of a building data model is not new. It has been the subject—in fact the "holy grail" almost—of architectural CAD research right from the mid-1970s, when the first attempts were made to develop integrated design systems that could support a suite of applications capable of operating together rather than just individually. A single building model is the central piece around which such integrated systems, dealing with all aspects of design, construction, and facilities management, can be built. A building being such a complex entity, with so many different systems, subsystems, and components intricately related together, defining a good data model for it is by no means an easy task. That is why research on this topic is still ongoing. My own Ph.D. research was devoted to a subset of this problem—developing a data model that will represent, in an integrated fashion, both the spatial and structural components of the building so that the same model can be used to plug in architectural analysis tools, structural analysis tools, as well as tools that can evaluate the synthesis of space and structure.

The IFC building model by the IAI represents the latest effort, jointly by research organizations and commercial vendors, to develop such an integrated building model (see Issue #68: http://www.cadenceweb.com/newsletter/aec/0202_1.html). An excellent and detailed overview of the key research work in building modeling can be found in the book "Building Product Models: Computer Environments Supporting Design and Construction" (CRC Press, July 1999, see http://www.amazon.com/exec/obidos/ASIN/0849302595), authored by Charles M. Eastman, a pioneering figure in CAD research. I had the privilege of reviewing this book for the journal "Automation in Construction" (Volume 11, Issue 4, June 2002, Page 495, see http://www.sciencedirect.com/science/journal/09265805).

Autodesk's "Building Information Modeling" event says – The Future is Revit

The Autodesk "Building Information Modeling" event that I attended sent out one resounding message to all existing and future Autodesk customers from the building industry—Revit is the platform of the future. Both Carol Bartz, Chairman, President, and CEO, and Phil Bernstein, VP, Building Industry Division, presented persuasive arguments as to why this should be so: Revit has been developed from the ground up with a single building data model at its core (the significance of which was explained in the previous section); it incorporates sophisticated parametric modeling capabilities that simplify the creation and editing of building entities; it has automatic change management capability that immediately synchronizes all graphical and tabular views of a building when a change is made, eliminating the inconsistencies found in construction documents created with conventional CAD software; it has intelligent built-in relationships between building components as well as the ability to define custom relationships and dimensional constraints, which are maintained when changes are made; it frees up the user to concentrate on design tasks, with the system doing the tedious, repetitive work; it has a fresh approach—no more Xrefs and layers, and the concomitant management hassles; and, it incorporates the latest programming concepts, which means no more "messy old code." (For an overview of Revit, see Issue #72: http://www.cadenceweb.com/newsletter/aec/0402_1.html.) With Revit, the building information can be captured in a digital format, and more importantly, preserved in that format for re-use at all stages of the building lifecycle—from design, through construction, and to operation and maintenance. Revit can thus become the cornerstone of Autodesk's future vision of its technology being used for "Building Lifecycle Management" and not just "Design," enabling architects to also provide (and charge for!) professional services that extend well beyond the realm of design into the operation and maintenance stages of their creations, just like their counterparts in the manufacturing and service industries.

Other highlights of the event included live demos of Autodesk Revit in action, illustrating the benefits cited above, along with demos of Autodesk Buzzsaw Professional and Autodesk Building Systems (ABS). The collaboration capabililities of Buzzsaw were emphasized as being another centerpiece of the overall "Building Lifecycle Management" vision. While pointing to Revit as the future in no uncertain terms, Bartz and Bernstein sought to assure their existing customers that the company was also committed to honoring the past. AutoCAD and ADT would continue to be supported, although ADT users are being urged to switch to Revit. As for the practical issue of compatibility, Revit has fully functional DWG capability for exporting drawings to consultants not using Revit. While the current ABS works on top of ADT and won't work with Revit, development is ongoing to provide the same MEP functionality in Revit. In addition to providing training and authorized re-sellers, Autodesk is also starting to implement professional services that will provide guidance on how Revit should be used to derive maximum benefit. Full-blown structural representation in Revit is still about a year and a half away, but the ability for multiple users to work on one model concurrently is being developed and should be available soon.

Conclusions

When Autodesk acquired Revit last spring, I pondered over the future of Revit in Issue #71 (see http://www.cadenceweb.com/newsletter/aec/0302_2.html), and saw two distinct possibilities: would the industry benefit by Autodesk's promotion of Revit's parametric building modeling technology and finally see an end to the days of dumb 2D drawings; or, would this be the epitaph of a creative and innovative company? I am happy to see that it is the first prediction playing out rather than the second. It takes tremendous courage and confidence for a technology company to adopt a brand new product strategy and give up the existing one despite its dominant market share. With the acquisition and promotion of Revit as the primary product for the AEC industry, as well as the development of innovative tools like Autodesk Architectural Studio inhouse, Autodesk has shown that it is not content to rest on the success of its flagship product, AutoCAD, and is keen to forge ahead with newer and better products that will benefit the building industry.

With regards to "building information modeling," the story is far from over; in fact, a new chapter is just beginning with the acknowledgment of its importance by CAD vendors. A tool like Revit may have a relatively superior building data model compared to other tools, but this does not mean it is the best possible. Researchers in building modeling are still developing models to most effectively and efficiently represent building entities and their inter-relationships, with capabilities and intelligence that go far beyond what even Revit currently has. CAD vendors would be well advised to look more closely at this research. Take the case of collaboration, for example. Research has envisioned collaboration as a "live" event, with multiple discipline-specific applications interacting in real-time with a central building model via the Internet and sharing required data with each other, making the design process much more effective. This is a far cry from the current state of the art, exemplified by Buzzsaw Professional, where you are simply redlining drawings as you do manually, but not interacting with the digital building model in real time.

In general, a much better synergy is needed between university research and industry implementation in the building industry and the technology industry that supports it; currently, there is too much of a lag. There are many more innovative ideas in CAD research such as generative design systems; precedent-based design tools; evaluation and analysis tools for all aspects of building design including "soft" criteria such as form, habitability, circulation, etc.; tools for capturing design intent; and so on, that would greatly advance the state of the art in our industry if they were to be translated into commercial tools. We need to draw inspiration from the field of EDA (Electronic Design Automation, or CAD for designing semiconductor chips), which is very advanced compared to CAD for AEC primarily because of the close ties between universities and industry. Academics doing CAD research related to buildings should not remain content to develop their theories and concepts in ivory towers with no regard to implementation; at the same time, the industry needs to be more aware of and sponsor research work in CAD at universities, and implement those concepts and ideas into tools for the profession at large.

About the Author

Lachmi Khemlani completed her Ph.D. at UC Berkeley, specializing in architectural CAD, and continues to teach, write, research, and consult in this field. She is the author of "Into 3D with form•Z" (McGraw-Hill, June 1999), and can be reached at lachmi@arcwiz.com.