

# The Secret Of BIM

By John Chadwick, AIA, RIBA

It's not just the cutting-edge 3-D technology or the photorealistic renderings it produces, it's the way Building Information Management affects design collaboration that's truly revolutionizing how we build learning environments.

Architects and engineers have been using computer-aided drafting (CAD) programs to design all types of buildings since the 1970s. And although the technology has evolved over the years, its benefits to education design and construction have been remarkably few. This is mostly because CAD drawings have remained two-dimensional, making the whole CAD format not that far removed from traditional hand-drawing. Some owners could even argue that the drawing quality—and therefore the effectiveness of the planning process—has declined with the use of CAD programs.

Fast forward to present-day education design and construction, and it's clear that the advent of Building Information Management (BIM) technology has not only picked up where CAD left off, but it has also enhanced the collaborative elements of the design process. The trend began in the early 1990s—and ever since then, BIM technology and the three-dimensional computer renderings it produces have become increasingly sophisticated. In fact, renderings have become so photorealistic that they could even raise false expectations among owners and architects, who become too committed to a design before it has been reconciled with the program, the budget, and the detailed CAD documentation needed for construction.

Indeed, CAD-generated renderings have

not materially transformed the way architects and engineers develop their designs or the way they communicate with their clients and the construction contractors. Rather, 3-D BIM technology programs, including Revit by Autodesk and Bentley Architecture, integrated with more accessible rendering programs—such as Google SketchUp, which is itself integrated with Google Earth—are rapidly replacing two-dimensional CAD programs, and revolutionizing the way we create learning environments.

BIM technology programs are transforming and improving the entire process of design, procurement, and construction. Because they are accurate—and essentially create a virtual building that mimics the future construction process—BIM programs improve the way designers think in three dimensions. They integrate databases so that every component of construction can be identified and quantified, and they greatly facilitate coordination and collaboration because all design team members work in a single virtual model, no matter where they are located.

But the most important BIM benefit to owners and users of educational facilities is the design team's ability to communicate in three dimensions throughout the design process. With BIM, everyone—including students—can understand what's being proposed, not just the few who have been trained to read two-dimensional plans, sections, and



This BIM-generated rendering illustrates the renovated classroom and window space for Thomas Jefferson Middle School in Arlington, VA.

RENDERING COURTESY OF PERKINS EASTMAN

elevations. This means more individuals can contribute to the process and the completed project is more likely to satisfy hopes and expectations.

### Benefits and Benchmarks

The database capabilities of BIM technology offer several notable benefits. For example, educational specifications are integrated with the building model from the outset. Existing and proposed facilities are analyzed, compared, and benchmarked in numerous ways to achieve equity and improve space utilization. Then, consider the bottom-line benefits:

- Because of its realistic presentation, BIM allows the project's design to be more easily quantified. Therefore, it's more likely that pre-construction cost estimates will be more accurate.
- BIM greatly facilitates coordination of architecture and engineering documentation, which helps reduce time and capital expenditures during construction. The BIM process highlights conflicts for resolution before construction begins.
- BIM's realistic presentation works especially well for planning renovation and modernization projects, which helps

minimize construction's impact on the faculty's work flow and class schedules.

BIM also helps the design team achieve its goals for high-performance facilities that improve student outcomes. It enables designers to study, for example, how the building will interact with the natural environment outside: the path of the sun, the shadows it creates, and the lighting conditions it provides in a classroom through the course of the day and the seasons. The technology facilitates the integration of natural light with artificial light to create lively glare-free conditions under which students can focus and absorb more, while also reducing energy consumption.

During design and construction the design team can share copious data and the great variety of two- and three-dimensional drawings that BIM can produce with educators to support opportunities for innovative, project-based learning. After occupancy, BIM technology can support the building's learning objectives and sustainable goals by providing specific data for ongoing maintenance and operations.

### Technology at Work

Thomas Jefferson Middle School, part of

the Arlington Public Schools system in Virginia, dates back to 1972. The school, which shares its gym and theater with the community, is an early and successful example of the school-as-center-of-community concept. However, the school building itself is attached to the gymnasium in a two-story, deep-plan volume—with only one exterior wall and a total of 13 small windows admitting natural light, design features that limited the effectiveness of this outstanding International Baccalaureate middle school.

Since the original construction drawings were available, the design team created a virtual model and three-dimensional survey of existing conditions using BIM technology. The resulting model proved to be an invaluable tool for analysis and communication as the project developed because it facilitated a great deal of community interaction. The BIM-supported process also helped hone the project's scope. For example, the project started as a comprehensive renovation project. It then became a complete rebuild of the school portion of the facility. And finally, due to budget constraints, it reverted back to a limited improvement project, adding windows



**This rendering, prepared during concept design/program development, presents a detailed look at a computer lab in the proposed Northern Virginia Community College Higher Education Center, to be located in Loudoun County, VA.**

RENDERING COURTESY OF PERKINS EASTMAN

and skylights and replacing finishes and major mechanical equipment. BIM has also assisted the team in managing the seven phases of construction needed to keep the school operating safely throughout the academic year.

In another example, Northern Virginia Community College (NOVA) in early 2009 solicited help with assessing its facilities inventory and utilization data for 42 buildings on six campuses and seven centers, totaling just over 1.5M gross square feet. The design team first verified existing CAD drawings and space utilization data on site, then created accurate BIM models of every building that included utilization data conforming to the State Council for Higher Education in Virginia (SCHEV) classification system. Since the data is readily exportable from the BIM models to a spreadsheet program, the design team was able to analyze space inventory, space utilization, and enrollment to provide copious information and raise important questions about how space is used on each campus, and how utilization varies between campuses. The design team found that on all but one campus the space available was approximately half of what is permitted under SCHEV standards. Space utilization challenges on the one campus that did approach the standards were attributed to specialized uses and to a particularly high proportion of non-credit courses that do not count toward SCHEV standards. Previously, NOVA could not access such detailed information, highlighting BIM's

ability to support ongoing planning and help maximize space utilization. This is especially valuable as community college enrollment nationwide continues to rise at a rapid rate, and funding for new facilities cannot keep pace with demand.

### Community College Challenge

In another NOVA example, the analysis of an earlier master plan combined with the BIM space analysis for the community college's Loudoun Campus prepared the design team well for the programming of a new 40,000-square-foot Higher Education Center. Other than two specific program spaces, a recording studio, and a GIS laboratory, the initial program called for a variety of classrooms and informal learning spaces. Because programs change and evolve so frequently to meet students' needs, classrooms on this campus do not correspond to any particular department—unless the classes are so specialized that no other department can use them.

Keeping flexibility top of mind, and based on the average and maximum numbers of students in traditional versus computer laboratory classes, the design team developed a standard classroom module that can accommodate up to 40 students in a traditional class and up to 28 students in a computer laboratory. Technology infrastructure allows each classroom module to be used as either a traditional classroom with loose furniture or a computer laboratory with fixed furniture, and will also allow the use and layout of each room to change throughout the life of the building.

Using BIM technology, the design team developed a variety of layouts for both fixed and loose furniture that would encourage collaborative learning and take full advantage of technology. From the BIM model the team developed three-dimensional drawings in SketchUp to show faculty and staff the wide variety of layouts possible within the same classroom. They also made SketchUp drawings of the other spaces proposed for the building, including informal learning spaces, open faculty and adjunct-faculty workstations, and a multi-use event space, to demonstrate how every space in the building could be used to encourage learning and collaboration. The three-dimensional drawings generated invaluable comments and feedback that were used to revise and strengthen the design.

### Starting Blocks

While BIM technology far exceeds CAD's capabilities, it is still only in its infancy and its power to transform how we design, procure, and construct buildings remains largely untapped. In many instances, design teams still use BIM programs to produce two-dimensional construction drawings, and for the most part the technology is less developed for mechanical and electrical engineers than it is for architects and structural engineers.

Additionally, for various liability reasons design teams are still reluctant to share BIM models with contractors. Though it remains to be seen just how transformative BIM technology will prove to be, it certainly has the power to break down the barriers between the owner and the various members of the design and construction teams. It enables greater communication and collaboration among them—and that is making all the difference in the design process. Implementation of BIM technology should also lead to more pre-fabrication, higher quality construction, and buildings that more specifically meet owners' expectations and maximize designers' creativity. And in the end, it's the students who benefit most. ■

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