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CONSTRUCTION: COMPANIES

Building Digitally Provides Schedule, Cost Efficiencies

4D CAD is expensive but becomes more widely available

by Andrew Roe

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In the ongoing quest to improve project planning and anticipate field problems before they occur, a growing number of construction professionals are using computer technology to build projects digitally before actual construction begins. Four-dimensional CAD, which combines 3D computer-aided design with the time element of scheduling software, is gaining a foothold at construction sites after years of incubation in academia and niche sectors of the construction industry.

New PC-based 4D tools are helping designers, contractors and owners visualize how projects are built. But major time investments required to build 4D models may limit widespread acceptance.

Early adopters say 4D is most useful on complex projects. "It really helps with coordination and sequencing issues," says **Peter Allen**, project manager for general contractor DPR Construction Inc., Redwood City, Calif. On the \$72-million Bay Street entertainment and retail complex in Emeryville, Calif., DPR used 4D CAD to help win the job and shave several weeks off the project schedule, he says.

With several steel-framed retail buildings, a five-level concrete parking garage and a steel-framed movie theater complex located above a three-level concrete parking garage, Bay Street required tight scheduling of concrete placement and steel erection. By running a 4D simulation using InviznOne software developed by Walt Disney Imagineering, "we found we could accelerate the steel in the theater area and save three weeks," says Allen. The first phase is scheduled to be completed in October.

Disney's InviznOne tool, to be marketed commercially by a yet-to-be-named start-up, is one of several products that perform 4D modeling. While operating procedures vary, most 4D products link 3D building components with activities from a computer-generated schedule to simulate construction of buildings

and other structures. 3D CAD data from AutoCAD, Microstation and other platforms can be imported into the 4D software and arranged so building components correspond with construction activities. A concrete floor slab, for example, might be subdivided into pour zones, rather than shown in its geometric design layout.

Schedule data can also be imported from various platforms such as Primavera Project Planner and Microsoft Project, as well as generic text files, says Kathleen Liston, a 4D consultant who helped develop InviznOne. Each activity in the schedule can be linked with one or more corresponding objects in the 3D model, enabling the construction sequence to play out like a movie.

The virtual construction scenes can help teams plan interim activities such as concrete formwork, crane operations and material laydown, says Bill Krill, structural operations manager at San Francisco-based Swinerton Builders, which is using 4D software from Virtual Step Inc., Hayward, Calif., to build a \$28-million office complex in San Francisco. "It helped us identify crew sizes and probably saved 10% on the overall schedule," he says.

Swinerton is also using VirtualSTEP's tools to plan construction for the \$80-million San Francisco Conservatory of Music, where a combination of new construction and the rehabilitation of existing structures will require intricate phasing when construction begins later this year.

"We have to know where to work so we don't box ourselves out from the site," says Krill. Swinerton has also used VirtualSTEP to import 3D building components from a Web-based library.

While contractors appear to be the primary champions of 4D CAD, owners and designers also are figuring into the mix. Computer chipmaker Intel Corp. has used PM-Vision from CSA Inc., Marietta, Ga., to plan a new \$400-million-plus fab facility near Portland, Ore. Art Stout, Intel's director of emerging technologies, says 4D modeling has "eliminated a lot of design conflicts and physical mockups" on the project, managed by Hoffman Corp., Portland, Ore., and slated for completion later this year.

Stout says CSA's database-oriented approach offers long-term benefits by allowing embedded maintenance schedules, operational schematics and other disparate documents within the model. He

eschews the term 4D for a more encompassing "XD," signifying multiple databases working in concert over a project life cycle.

CSA was one of the early developers of 4D modeling, developing software used to plan large nuclear powerplants in the 1970s, says Amadeus Burger, CSA president. Companies such as Westinghouse and Duke Energy Services are using CSA tools to plan the next generation of nuclear plants, he says.

But benefits need to be weighed against the time investment to build models. Allen says DPR spent over 300 man-hours building a 3D model of Bay Street, primarily because only 2D CAD data was available. "But we'll recoup it in time savings," he says.

William A. Cook, senior vice president for urs Corp., Los Angeles, agrees that "cost is still a hurdle," but notes that time investments can drop from several weeks to several days as 4D tools mature and more projects are designed in 3D. urs is using InviznOne as construction manager on a \$230-million addition to the Santa Monica/UCLA Medical Center, where a new addition is being built adjacent to two existing buildings, one of which will be demolished. "We found several phasing issues" using 4D and avoided potentially costly change orders, he says.

The availability of 3D design data has been a stumbling block, says Martin Fischer, director of Stanford University's Center for Integrated Facilities Engineering and a longtime 4D researcher. Much of today's 3D CAD data is based on simple CAD entities and not on still-evolving industry-standard object definitions, he says. Also, owners are often unwilling to pay for true 3D design and liability-conscious designers are often unwilling to share data, he notes.

Several other vendors have introduced 4D tools in recent years. Bentley Systems Inc., Exton, Pa., has upgraded Schedule Simulator, a tool developed at Jacobus Technology, which Bentley acquired in 1998, and has merged it with its Dynamic Animator program for enhanced visualization. Intergraph Corp., Huntsville, Ala.; Balfour Technologies LLC, Bethpage, N.Y.; and Visual Engineering, New York, N.Y., also offer 4D software.

Some firms have bypassed commercial 4D tools and developed in-house solutions. Denver-based Company 39, a Parsons Brinckerhoff subsidiary, has tied Primavera schedules with 3D Studio Max animation to visualize airport construction, says Doug Eberhard, chief technology officer at Company 39.

"Not all projects lend themselves [to the 4D tools]," he says, citing long, narrow highway and transportation projects. "And ultimately it depends on what the client is willing to pay for."