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4D Modeling

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EMERGING CONSTRUCTION TECHNOLOGIES

Other Technologies – Equipment Automation

4D MODELING

THE NEED

Traditional design and construction planning tools, such as 2D drawings and network diagrams, do not support the timely and integrated decision making necessary to move projects forward quickly. They do not provide the information modeling, visualization, and analysis environment necessary to support the rapid and integrated design and construction of facilities. Synthesis of construction schedules from design descriptions and integrated evaluation of design and schedule alternatives are still mainly manual tasks. Furthermore, the underlying representations of a design and a construction schedule are too abstract to allow the multiple stakeholders to visualize and understand the cross-disciplinary impacts of design and construction decisions. In the future, 4D technologies will be used for planners, designers, and engineers to analyze and visualize many aspects of a construction project, from the 3D design of a project to the sequence of construction to the relationships among schedule, cost and resource availability data. These intelligent 4D models support computer-based analysis of schedules with respect to cost, interference, safety, etc., and improve communication of design and schedule information.

THE TECHNOLOGY

Extending the traditional planning tools, visual 4D models combine 3D CAD models with construction activities to display the progression of construction over time.

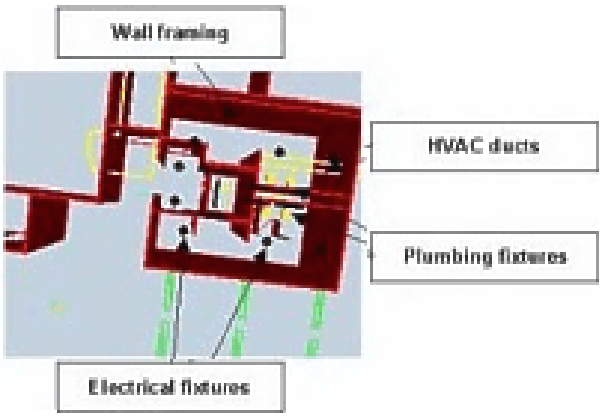

FIGURE 1 THE 4D MODEL CAN VISUALIZE A LOT OF WORK THAT IS ONGOING ON IN A PARTICULAR AREA AT THE SAME TIME

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However, 4D models are very time-consuming to generate manually and cannot currently support analysis programs. The difficulty and cost of creating and using such models is currently blocking their widespread adoption. The construction knowledge necessary to build 4D models has been formalized and developed by a methodology that guides project planners in generating 4D models from 3D product models. This formalized knowledge enables project managers to create and update realistic schedules rapidly and to integrate the temporal and spatial aspects of a schedule as intelligent 4D models.

BENEFITS

The 4D models have helped project stakeholders:

- Understand the relationship between construction activities and facility operation for retrofit projects,
- Understand and improve the use of work, access, and staging areas over time,
- Identify spatial conflicts among crews and other production elements,
- Analyze activity sequencing,
- Improve constructability,
- Improve work flow for subcontractors, and
- Visualize the construction work to be done for a work zone, time period, or subcontractor

STATUS

A few commercial 4D modeling tools allow a user to link a 3D model with a construction schedule to visualize construction over time on a computer screen. While the underlying 3D model and schedule model are based on object-oriented concepts and can be queried by the user about their content and relationships, the resulting 4D model is purely a visualization. 4D CAD has been used at various levels of detail from simulating and coordinating the overall phasing of a project to coordinating the daily work of a group of subcontractors. At the Center for Integrated Facility for Engineering, Associate Professor Martin Fischer has lead research projects related to 4D CAD since 1994. The first project, sponsored by Dillingham Construction and performed by Eric Collier, involved the development of a 4D model to communicate the four-year construction project of the San Mateo County Health Facility. Due to the success of this project, Martin Fischer continued to pursue research related to 4D models, focusing on improving 4D tools and the value of 4D models in design and construction.

BARRIERS

Ad-hoc modeling approach: They are built in an ad-hoc manner without a methodology that guides their generation. This makes updating and maintaining a 4D model cumbersome by anybody else but the original creator.

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Single level of detail: They are built at a single level of detail and do not support seamless aggregation, elaboration, and refinement of model detail. This hinders the collaboration of general contractors and subcontractors, since they work towards the same goal, but at different levels of detail.

No computer-based analysis: They do not support computer-based analyses of cost, safety, and other performance metrics. With visual 4D models, users must carry out all of the reasoning about what they see in their heads. If properly represented, the information necessary to build a 4D visualization could support cost estimating and many other kinds of analyses of a design-build alternative. To support such analyses, 4D models must represent time explicitly and cannot consist of a simple sequence of 3D model views.

Single user environment: They are available only for single-user desktop environments. However, many project participants need to participate in building and critiquing a 4D model.

Points of Contact

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Reviewers

Peer reviewed as an emerging construction technology

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