Georgia Tech

Research News

Georgia Institute of Technology
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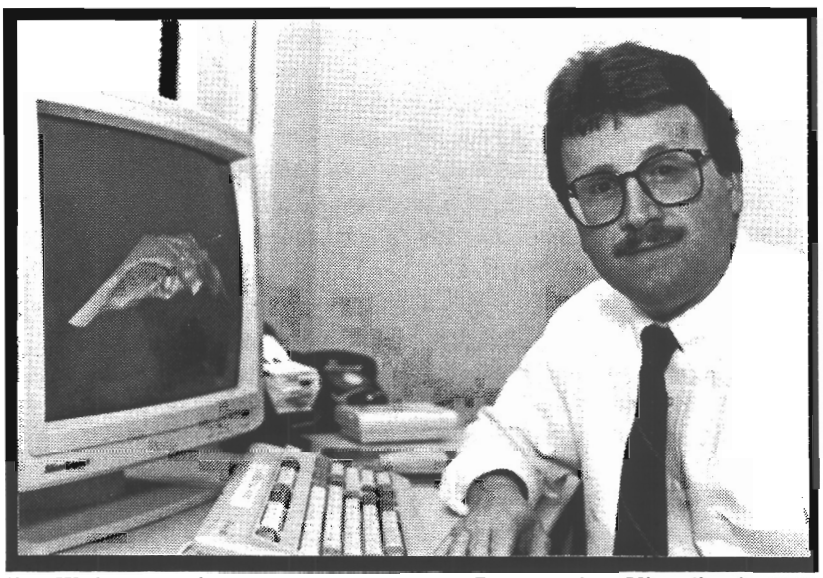
For Immediate Release
September 9, 1991

COMPUTER GRAPHICS SIMULATION COULD IMPROVE PLANNING OF CONSTRUCTION SITE FACILITIES

Organizing people, materials and machines to work effectively could become easier for construction managers with help from a computer visual simulation being developed by researchers at Georgia Institute of Technology.

The Construction Visualizer (CV) would let managers simulate construction processes at a particular site -- to plan equipment and material placement, for example. The simulation would provide information in three dimensions and as real-time simulations, said Dr. Walter Rodriguez, associate professor and chairman of the Engineering Computer Graphics Program in Georgia Tech's School of Civil Engineering. The visual simulations would include input from all key planners involved in design and construction processes.



Dr. Walter Rodriguez demonstrates the Construction Visualizer's (CV) topography simulation option, showing contour changes resulting from different actions. (Color slides, b&w photos available.)

"We can use this as a tool for visualizing and prescribing the best plan, shape or arrangement within that space," Rodriguez said of his research, sponsored by the National Science Foundation. "Ultimately, we hope to improve the dynamic communication between all the people involved -- the client, architect, engineer, contractor and workers -- using visual means."

CV is being developed in C programming language and uses a UNIX-based workstation to display several different construction situations. One option depicts material hoister, or elevator, operations programmed to simulate those of a hoister on a future construction project. Workers and equipment at different floors moving a variety of materials are also represented, said Augusto Opdenbosch, a graduate student working with Rodriguez on the project.

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"The actual simulation tells how long each person had to wait," Opdenbosch said. "You can specify that you have, for some reason, certain people going between two floors a lot, and then change certain parameters (to obtain the desired design results)"

Another option of the visual simulation program addresses crane operations. The site manager whose crew is installing panels on the 10th floor of a building, for example, could factor in the speed, angular movements, reach and dimensions of the crane's boom; the material hoister's specifications; workers' paths; and even the topography and dimensions of the site. The system would help supervisors decide on the best place to locate not only cranes but also building materials and construction support activities such as steel fabrication.

Some construction managers plan site facilities by drawing a layout on paper -- but in many cases, the layout becomes obsolete before it is even finished. The needs of sites change quickly because of the dynamic nature of construction operations, Rodriguez noted.

"Say, for example, that a builder places a tower crane in one location and the steel reinforcement fabrication facility in another spot within reach," he said. "As the project progresses, what appeared at first to be good location becomes a material handling problem. In addition, when contractors draw a site layout, it only has two dimensions -- rather than the three dimensions plus time needed to fully visualize and prevent, for instance, a collision between two cranes."

The tools being developed would avoid this situation and should help enhance construction site productivity.

Another program has been developed to simulate site topography -- the hills, valleys and rivers on which bridges, buildings, roads and other civil engineering projects are constructed. The visual rays producing the image are traced from known points on the terrain's surface to the observer's position, instead of the usual other way around, Rodriguez said. Reverse ray tracing allows realistic visual representations of complex shapes. Based on the site's geographical data, a designer can alter the topographical model on the computer screen. The designer can increase the vertical axis, for example, to exaggerate hills and valleys and visualize tiny contour changes caused by a particular design decision.

Engineer/architect Rodriguez became interested in improved planning of construction operations while he was supervising the construction of the $20-million Federal Building and Courthouse project in San Juan, Puerto Rico during the 1970s. The concrete batch plant was arbitrarily located at one end of a very large site. Additional facilities and materials were spread everywhere.

"I noticed all the travel time wasted by the subcontractors," he said. "People were waiting for materials and doing nothing, just because the supply facilities were so far from each other -- something had to be done to improve site productivity."

He saw similar problems on a very crowded construction site for the University of Florida's football stadium while studying for his doctorate at the Gainesville school. He noticed that the contractor had to move the concrete batch plant three times during construction, a street had to be closed -- and still, the trucks involved had difficulty loading and unloading materials.

Rodriguez also wants to improve the way engineering projects are designed -- not just the way they are built. He uses computers to simulate design and construction processes before projects are actually built.

"Visual simulation allows the design team to manipulate time -- the fourth dimension," he said. "We can go back and forth in virtual-time and make design changes in response to problems detected while modeling the project on the computer and play 'what-if' games ... it's like having your own time machine.

"We have had a lot of interest in this project, particularly from large construction companies in the U.S and abroad," Rodriguez added.

The researcher also would like to develop visual thinking tools to allow students, designers and builders to communicate and reason with images, rather than just with words. Such tools would enhance the user's ability to communicate and think *visually*, as well as verbally and mathematically.

"The visual thinking tools we are planning are not necessarily artificial intelligence or expert systems," he explained. "These new tools will be like adding another dimension to the human mind."

This material is based upon work supported by the National Science Foundation under Grant No. E-20-683. The government has certain rights in this material. Any opinions, findings and conclusions or recommendations expressed do not necessarily reflect the views of the National Science Foundation.

Dr. Rodriguez authored ENGINEERING VISUALIZATION: THE MODELING OF DESIGN IDEAS, available December 1991 from McGraw-Hill.