3D Flythroughs
It's Child's Play

Jonathan W. Lowe

This column covers the role of emerging technologies in the exchange of spatial information.

As a little boy, I promised my Mom that I'd keep my bedroom clean for the rest of my life if only she'd get me a Dune Buggy Wheelie for my birthday. It was a tempting offer, but Mom hesitated. As a truly idealistic person with high hopes for her children and our society, she must have wondered how a radio-controlled toy car could possibly improve either her son's character or the world in general. Today's kids make similar desperate pleas for the latest photo-realistic video game technologies, such as Sony's PlayStation II. Unlike the Dune Buggy Wheelies of my childhood, however, today's electronic games may actually benefit (if indirectly) society.

The advances in capabilities of graphics cards, fueled by the demand for ever-more-realistic video entertainment, is making real-time 3D visualization available to desktop GIS users. Until recently, real-time visualization of geographic data required a high-end Silicon Graphics workstation and complicated, expensive software packages. Now, with an Nvidia or 3DLabs chipset shipped automatically with most desktop PCs, the same startlingly real, user-directed flythroughs are available economically even on laptop computers. So go ahead, get Joey that PlayStation; it may not improve his grades, but it might benefit the GIS community!

Courtesy of Evans & Sutherland

As 3D technology matured, flythrough designers increased the realism of their scenes

Learning to fly

The new generation of graphics cards may benefit urban communities trying to forge a participatory neighborhood plan. The practice of community and government partnership in the urban design process became popular in the 1960s and persists today. In this process, professional urban planners hold meetings with the local community members who will be most impacted by an urban construction project like a new park, freeway, soundwall, or housing block. In early participatory efforts, the technical jargon and graphic tools of the planning process created a gulf between professional planners and the public, sadly re-emphasizing the disparity of power both were hoping to dissolve through cooperation. Few people are familiar with the plan-view and cross-sectional design drawings that architects and planners use daily. Without a common language for communicating design ideas, many attempts at cooperative planning failed or dragged on long past their projected completion dates.

While some frustrated planners blamed public ignorance for these difficulties, others searched for better communication tools. One discovery that planners tout today as a common language of urban design is 3D visualization, also known as an *urban simulation* or *flythrough*. An urban simulation combines flight-simulation technology (originally developed to train military aviators) with aerial photography in a computer-generated movie of a real place.

Building blocks. At first, flythroughs took weeks or even months to generate for a predefined route through the area of interest. The resulting simulations often required considerable imagination on the public's part; buildings appeared as textureless blocks, other features were vague blurs. There were no recognizable trees, people, or cars. Furthermore, the fixed paths did not always satisfy all participants, who might be more interested in the route past their home or the view from a higher or lower vantage point.

As the technology matured and in response to public dismay with the clunky graphics of early flythroughs, designers increased the realism of their scenes by adding computer-generated textures, trees, building facades, and people. Although these efforts may have improved the generic realism of a virtual tour, placement of the objects did not necessarily match geographic reality. The specialist making the model prettier was not neces-

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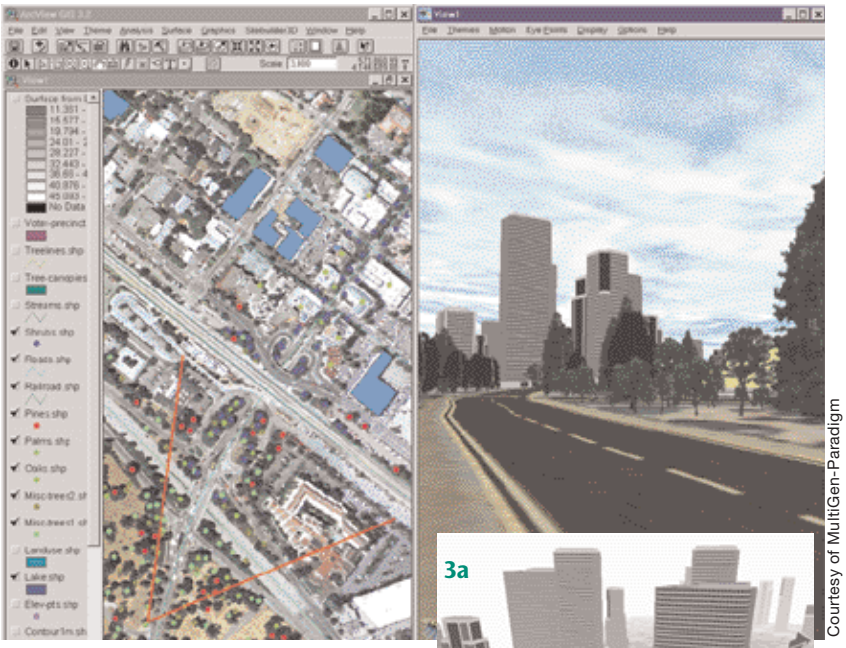
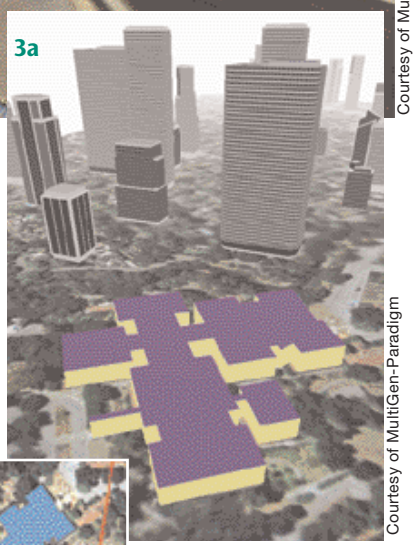
Courtesy of MultiGen-Paradigm

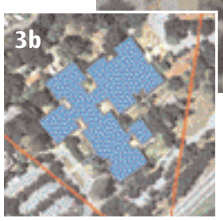
FIGURE 1 MultiGen-Paradigm's SiteBuilder 3D gives users a choice of object templates to assign to their existing point, line, or polygon features.



Courtesy of MultiGen-Paradigm

FIGURE 2 SiteBuilder 3D can simultaneously display the 3D flythrough and a 2D context map referencing the flythrough's eyepoint and range of view.





Courtesy of MultiGen-Paradigm

FIGURE 3a and 3b. High-elevation views — both oblique (3a) and nadir (3b) — of proposed construction makes traditional architectural plan views more accessible to the public .

sarily involved or even familiar with the actual neighborhood of interest.

Advances in the design community's use of high-end technology began in an academic environment. For instance, Bill Jepson of the University of California, Los Angeles' Urban Simulation Team pioneered the use of 3D flythroughs for urban planning and redevelopment projects in the early 1990s. Using modeling tools originally built for the flight and driving simulation communities, Jepson's team created real-time, 3D models of downtown Los Angeles, the university, Los Angeles International Airport, and other locations in conjunction with design and consensus building activities.

Cruising altitude

The initial problems of flythroughs — fixed flight path, inaccurate object placement, and lengthy production time — are now solved by the industry's latest 3D visualization products coupled with real-world, two-dimensional GIS datasets running on affordable desktop computers. Companies such as MultiGen-Paradigm (www.multigen.com), Evans & Sutherland (www.es.com), ESRI (www.esri.com), ERDAS (www.erdas.com), and Intergraph (www.intergraph.com) are all taking advantage of today's fast graphics cards to bring formerly high-end urban simulation to the desktop.

Urban planning. MultiGen-Paradigm has designed its urban simulation product, SiteBuilder 3D, to balance user-friendliness and accurate object placement. SiteBuilder 3D is an extension of ESRI's ArcView. Using traditional two-dimensional GIS datasets, SiteBuilder generates a 3D surface over which it drapes aerial or satellite imagery. Users then match points, lines, or polygons in their two-dimensional data with textures and objects from SiteBuilder's library. Points can be linked with tree objects (even specific tree species), lines with pavement objects, and polygons with building objects (see Figure 1). The objects appear at exactly the locations defined by the two-dimensional GIS data, preserving the scene's integrity with the original data. Some aspects of reality are ephemeral, such as clouds or fog — users can add these effects as well as simulating different times of day.

MultiGen-Paradigm also takes advantage of ArcView's existing two-dimensional mapping abilities to synchronize the location and viewing range (also known as the "eyepoint") of the viewer flying through the 3D terrain (see Figure 2). Users control the flight path, speed of travel, and elevation with the mouse. This means that traditional plan views can be delivered at participatory urban planning meetings in a more compelling and publicly intelligible format — like a view from a low-flying airplane rather than as a drafted construction drawing (see Figure 3).

Courtesy of Evans & Sutherland

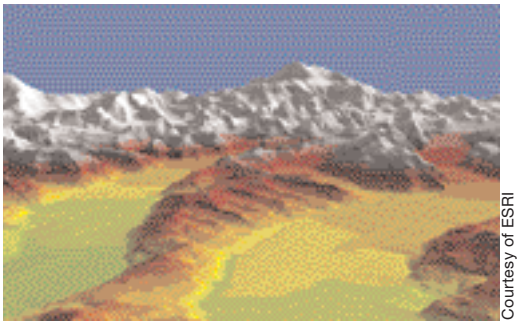
FIGURE 4 Evans & Sutherland's RAPIDsite makes pre- and post-construction visualizations available to real estate developers presentation to potential customers.

The defining feature of any 3D visualization, though, is its ability to perform smooth real-time rendering of the scene during the flythrough. SiteBuilder is quite smooth, even when running in full-screen viewing mode. Using a mouse to control the flight makes the flythroughs intuitive enough to allow untrained users, such as the public in a participatory urban design exercise, to investigate a plan from whatever vantage point they desire, on the fly (so to speak). And all thanks to a video game chipset built to entertain kids.

Finally, should SiteBuilder 3D users desire to add more detail to their 3D scene, the software can publish its scene to OpenFlight, MultiGen-Paradigm's real-time 3D scene format, and use other real-time 3D tools, such as MultiGen Creator or Vega, to build more enhanced or custom urban simulation applications.

Suburban development. Evans & Sutherland have also partnered with ESRI to offer an ArcView extension that generates simulations for real estate professionals interested in selling property before construction is completed. Unlike SiteBuilder 3D's emphasis on visualization of reality, the Evans & Sutherland product, RAPIDsite, encourages designers to insert objects that don't yet exist into their scenes, to communicate the contractor's vision of what may someday come into being. RAPIDsite's emphasis on fairly extensive real estate developments means that aerial photography and even existing contour data may not be available, since the construction may completely change the existing site characteristics (see Figure 4). Although the two products are similar in their capabilities and applicable to a variety of projects, SiteBuilder 3D and RAPIDsite seem to be targeting two different markets.

But, of course, there are numerous other three-dimensional modeling applications available for integration with GIS, including those from Intergraph (see "MGE Terrain Analyst" sidebar) and ERDAS (see "Stereo Analyst" sidebar).



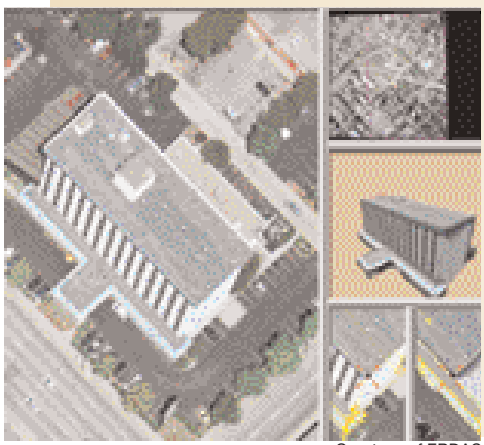
Courtesy of ESRI

FIGURE 5 Terrain modeling using ArcView 3D Analyst is more symbolic than photorealistic

ESRI has partnered with major players in deals that bundle the 3D visualization tools with ArcView. SiteBuilder and RAPIDsite enhance rather than compete with ESRI's own ArcView extension, called 3D Analyst, with their libraries of photorealistic objects and textures. On its own, ESRI's 3D Analyst allows ArcView users to create and modify surface models or generate shape files that include an elevation or *z* value along with traditional two-dimensional or *x*–*y* coordinates (see Figure 5). The scenes 3D Analyst draws are symbolic rather than photorealistic — although trees are recognizable as trees, they are obviously computer-generated stick trees, not specific species. Similarly, buildings are solid, single-color masses without windows, doors, or recognizable architectural features. For some applications, this level of modeling is perfectly adequate.

Stereo Analyst

ERDAS Stereo Analyst updates a user's GIS by superimposing existing 2D vector layers onto a digital stereo model, then allows the user to edit and reshape them to their real-world positions. Automated attribution techniques simultaneously populate a GIS during the collection of 3D data.



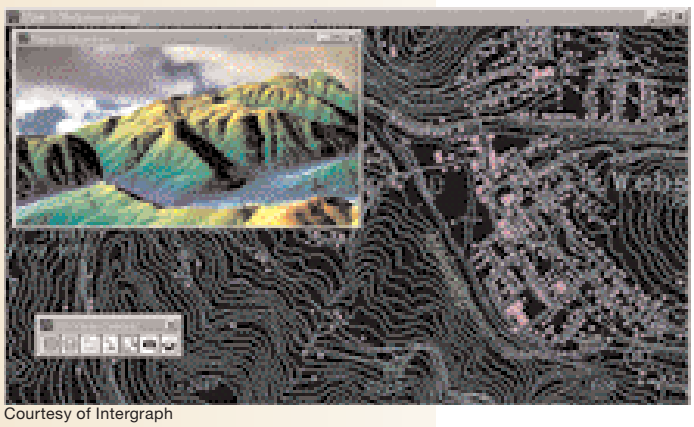
Courtesy of ERDAS

During the 3D data collection, the spatial and nonspatial attribute information associated with a GIS layer can be edited, and the attribute tables can be displayed along with the digital stereo model in one comprehensive environment.

Stereo Analyst is a standalone product and an add-on for ESRI'S ArcView GIS. The company will release an updated version later this year.

MGE Terrain Analyst

Intergraph's MGE Terrain Analyst can create, manipulate, display, and analyze digital terrain models that can be represented as triangulated networks (TIN) or regularly-spaced matrices (grid). Terrain models can be built from MicroStation design file elements; ASCII, DMA, and DTED formatted files; U.S. Geological Survey and SDTS digital elevation models, or existing TTN, GRD, or XYZ files. Output representations of the surface models include contours, color-coded elevation displays, wireframe displays, grid surface displays, shaded-relief displays, image draping, and drainage networks. Output file formats include TIN, grid, ASCII, and DTED. The software also provides a method for tagging contours, and for reading elevation values directly from a database. MGE Terrain Analyst also provides a method for tagging contours, and for reading elevation values directly from a database. It can be run standalone or with MGE Basic Nucleus for mapping and digital terrain modeling projects, and can incorporate a relational database for 3D GIS analysis.



Courtesy of Intergraph

Final approach

Wondering whether your existing PC can support this technology? Most Dell (www.dell.com) computers ship with the basic graphics cards required for these programs, and upgrades of existing PCs cost as little as $125 for an adequate new card. The software extensions to ArcView hover around $2,000. So, compared with their former high cost and platform requirements, 3D visualization tools are now available to almost everyone in the geospatial industry. Those interested in upgrading can review the valuable hardware comparisons from ESRI's graphics card benchmarking tests posted for public scrutiny at www.esri.com/software/arcview/extensions/cardlist. And once you've got the tools, you won't even have to keep your bedroom clean for the rest of your life. What a deal — thanks, kids!