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Architectural Rendering and Animation

by Rik Jadrnicek

During the design development stage of an architectural project, there is a strong need for powerful presentation tools. A standard set of working drawings provides adequate documentation, but a 3D visualization is often needed to provide a snapshot or a reality check to key players during the design development and approval cycle. Animation goes one step further by allowing you to "walk through" the structure long before the site has been cleared for construction.

While you can currently retrofit your existing CAD system with powerful videographic animation software and hardware, you must ask: how economically and practically can the two handle the task of animating the complex geometry of an architectural design?

To understand some of the problems encountered while animating architectural designs, this article will go through a simple design development cycle of an entry and conference room, including working drawings, rendering, and animation, using currently available software.

DATA GATHERING

During the programming stage of design development, the architect gathers information on the client's needs. Designs to satisfy those needs are conceptually modeled within the constraints of budget, time, site requirements, engineering studies, aesthetics, and public approval. During this process, the ability to quickly and economically present several alternative solutions is in constant demand.

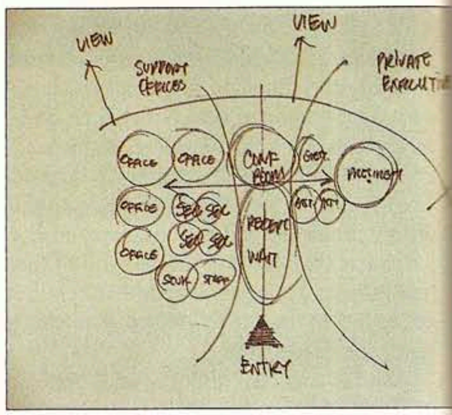
In this example, a bubble diagram (Figure 1) was hand drawn to explore required spaces, their sizes, and their relationships to other spaces. View considerations for the site were included. A floorplan sketch (Figure 2) emerged from this study. Elevation sketches (Figure 3) were created to explore 3D exterior and interior masses. (Many opportunities exist for computer animation at this stage, but here we will focus on animation *after* the development of working drawings.)

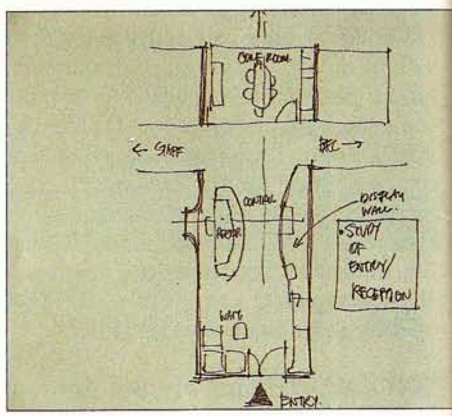
As the design matured, the drafting process began. Using AutoCAD, I developed a formal set of working drawings. To create the 2D and 3D architectural geometry, I used the AutoCAD AEC Architectural software package, a product licensed to Autodesk by ASG, Sausalito, California. Hardware consisted of a PC AT 386 with a PGA graphics card, a multi-sync monitor, and a digitizer tablet.

Our floor plan sketch evolved into a repository of information about doors, windows, walls, and resultant spaces. Door and window types and sizes were recorded. Walls, floors, and ceilings were assigned surface coverings, while spaces were filled with furniture and equipment. Background drawings emerged for use in creating a variety of engineering drawings. These working drawings included specifications and schedules for creating a formal set of contract documents.

Since AutoCAD AEC Architectural draws walls, doors, windows, furniture, and other fixtures in 3D, 3D views are always available. In the time it takes to regenerate the drawing, an orthographic view can be displayed. Turning off the text layers and removing hidden lines produces a simpler view after several minutes. In this example, a perspective view of the entry was created in wireframe (Figure 4). Using AutoShade, a solid shaded study of the entry was displayed in 256 simultaneous colors in 30 minutes (Figure 5). The actual rendering of a view can take minutes or hours, depending on the complexity of the drawing.

Using AutoFlix, animation software by Autodesk, I got a preview of what my animation might look like in RGB and dis-





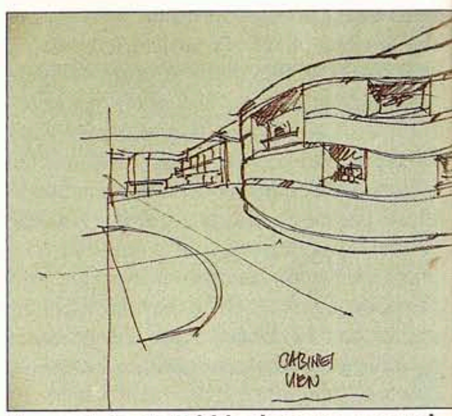


Figure 1 (top): Bubble diagram created during the programming stage of design development, showing entry and conference room. Figure 2 (middle): Rough floor plan sketch evolving out of the program stage of design development. Figure 3 (bottom): Interior elevation sketch of entry.

played it on the graphics monitor. An animated walk through the entry and into the conference room took another half hour of effort and several hours of machine time. The results were displayed in seven colors, presenting a rough view of the scene (Figure 6). The animation proceeded at about one frame per second, one-thirtieth of the speed of videotape.

Everything up to this point had been produced using the geometry created while developing the working drawings, introducing an important point often overlooked in the flash and pizazz of 3D modeling and animation. In order to economically justify the time it takes to develop animated presentations, it is important to minimize the duplication of effort. As much as possible, animation should be a by-product of the development of a set of working drawings. You should not need to recreate the geometry of a structure within a new 3D environment in order to produce an animated presentation.

Ideally, changes made during the creation of a presentation should be reflected back into the set of working drawings. In other words, the creation of working drawings and presentations should be a real-time interactive process, a primary goal within the microcomputer environment.

REALISTIC DESIGNS

The next step toward making the design more realistic was using videographic rendering and animation. While I did not need to recreate the geometry in the floorplan drawing, I did need to transfer it into a new 3D environment with a new set of capabilities. I used CADverter, a DXF translator created by Mathematica and marketed by AT&T Graphics Software Lab in Indianapolis, Indiana. I used GSL's TOPAS rendering and videographic animation software running on 4Mb of EMS RAM and a Truevision TARGA 16 board, which provided RGB and composite video in and out, and displays 32,000 simultaneous colors.

To prepare the drawing for translation from AutoCAD to TOPAS, I turned off layers containing text, targets, and other entities not to be rendered. CADverter will not translate geometry on OFF layers. Any entities that are to be manipulated separately from all other entities in the drawing need to be either a unique color on a layer or on a separate layer. This was not a problem, since AutoCAD AEC Architectural uses layers and colors to distinguish between most drawing entities.

I had to trim the drawing down to just the geometry seen during the animation and then create a DXF file of the drawing. The TOPAS environment will only accomodate a specific number of points, polygons, and vertices, depending on the amount of RAM available, which can cause problems for those wanting to animate complex geometry. In my drawing, the entry and conference room took up about 25 percent of the available TOPAS workspace, the full floorplan drawing was 276K, and the trimmed floorplan drawing was 70K.

The CADverter program was then used to convert the DXF file into an ASCII AMF file that was read and displayed by TOPAS (Figure 7) in about two minutes. The translation was one way only. A DXF file cannot be created from a TOPAS file; however, the IGES translator, also marketed by AT&T GSL, allowed a two-way transfer of geometry, although the process was slow and created very large files.

With the geometry in TOPAS, we began texture mapping the polygon surfaces with real-world textures. Textures were captured by camera and stored in RAM buffers. A stucco texture was mapped to the exterior wall polygons while wood (Figure 8) was mapped to selected interior walls, the entry desk, and the conference table. Up-

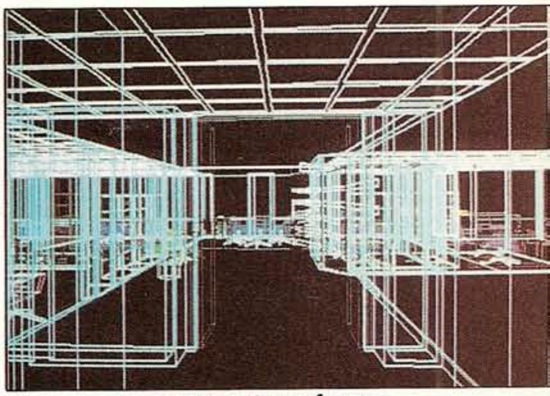


Figure 4. Perspective view of entry and conference room in AutoCAD.

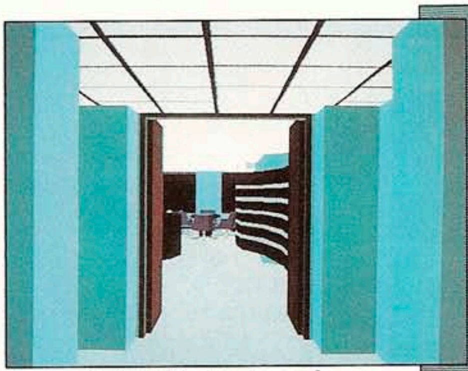


Figure 5. AutoShade view of entry and conference room.

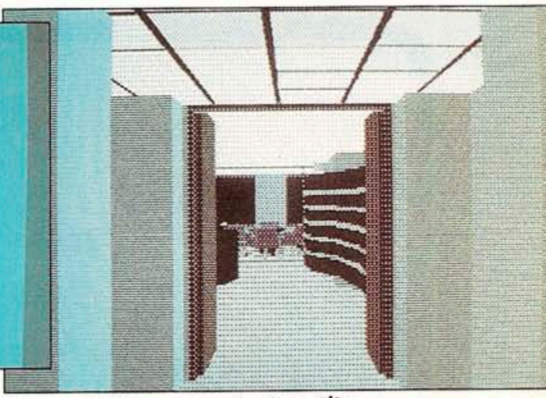


Figure 6. Same view in AutoFlix.

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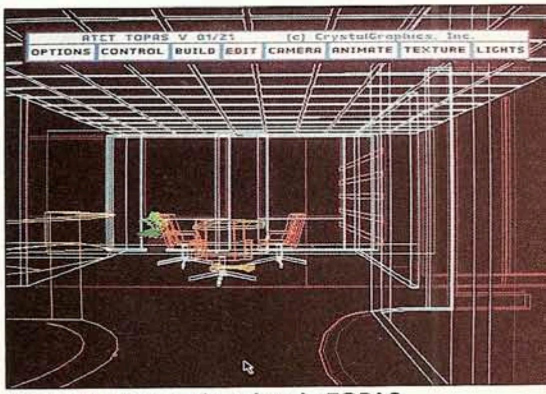

Figure 7. Perspective view in TOPAS after DXF conversion from AutoCAD. The geometry was not altered.

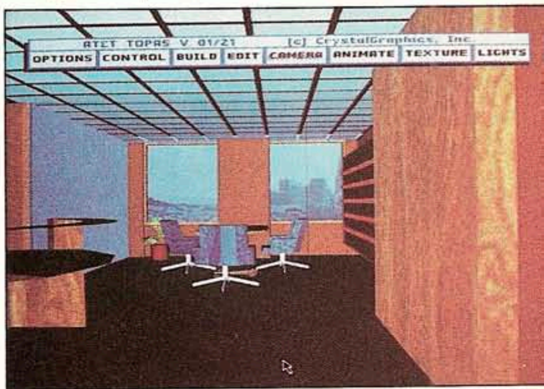

Figure 8. Videographic rendering displaying 32,000 simultaneous colors and texture maps. A polygon was created outside the windows and mapped with a texture of San Francisco.

holstery was mapped to the chair polygons.

The only change or addition to the geometry created using AutoCAD AEC Architectural was a plane I created outside the conference room windows and a texture of San Francisco mapped to the plane. Light sources were set and a view of the finished product was rendered (Figure 9). Capturing textures and mapping the surfaces took several hours. Rendering the view took less than two minutes.

These rendered views are nice additions to a presentation portfolio by themselves. They can be recorded to video, sent to a hard copy output device, or recorded on a high-resolution film recorder. Four-color separations can be created without great expense. However, to develop a full videographic walkthrough, the TOPAS animator module is necessary, and hardware such as a DiaQuest Animation Controller and a 3/4" Sony BVU 950SP editing VTR are needed. While these two items total more than $15,000, service bureaus and video production houses often offer their use as a service.

I began creating the 15-second animation sequence by setting keyframes for each position in the animation path where a change of direction or position was necessary for the camera, lights, or geometry. I previewed the animation sequence in wireframe and a crude solid render format in order to study the motion. The software calculated all the views between each keyframe ("tweens") and displayed the results in real-time. After a few modifications, I ran the animation out through the animation controller to the VTR. Setting up the animation and tweaking it took about two hours.

TOPAS rendered the first view along the animation path (less than two minutes), wrote the image out to the VTR, and recorded 1/30th of a second (one frame) onto tape. The screen cleared, and the next view along the animation path was rendered (another two minutes) and then recorded to tape. The process continued until the full 15 seconds of animation was recorded. Taking approximately one hour per second of animation, the program ran unattended overnight for 15 hours.

The result? A playback walked the viewer through the entry and into the conference room to sit down in a chair at the conference table. A realistic view of the environment was displayed in the animation sequence as well.

This 15-second segment was eventually edited into a larger presentation. I was generally pleased with the results, and my only complaints about this exercise were the limitations on the size of geometry I could work with and finding the time to become proficient with this powerful tool.

Videographic rendering and animation is alive and well in the PC environment. It is best suited and targeted towards private and corporate video production facilities requiring sophisticated rendering and animation of complex but small sets of geometry. Considering time and cost, it may be uneconomical for a small architectural firm, and considering the complexity of architectural geometry, it may be impractical for day to day studies and presentations of an architectural nature. But for any company currently using professional video to strengthen client presentations and corporate imaging, it provides an opportunity to rise above the competition. In the right hands, microcomputer animation is the kind of tool that could easily pay for itself with one use. ■

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