July 1994

CAID Currents: The State of CAID Art

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The State of the CAID Art

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I've devoted this column to an update on advanced software products that have found application in ID offices. By "advanced" I mean "fast" (requiring a powerful workstation running the UNIX operating system), with an extensive set of capabilities (requiring huge chunks of memory in the form of RAM and hard-disk storage). So these systems are not cheap.

While the price and performance gap between UNIX workstations and the latest generation of PCs, (the Power Macintoshes and Pentium-chip-based IBM-PC compatibles) has narrowed, the software I will discuss still runs only on UNIX platforms from the likes of Silicon Graphics, Sun, Hewlett-Packard and IBM. The software costs more than PC software, too. Not only because it does so much more, but because it must survive in a relatively small market: developers must spread extensive development costs over fewer sales. The bottom bottom line for an advanced CAID system, including hardware and software, hovers around $40,000 and many systems still cost more than $100,000.

Considering that cost range, it might seem that things haven't improved much over the past five or ten years. But, in real terms, the costs of advanced systems have plummeted when you take into account how much more performance you get for the dollar from today's workstations, and how much more the software can do. Until relatively recently, designers spent considerable time waiting for the computer to redraw new views of simple wireframe models.

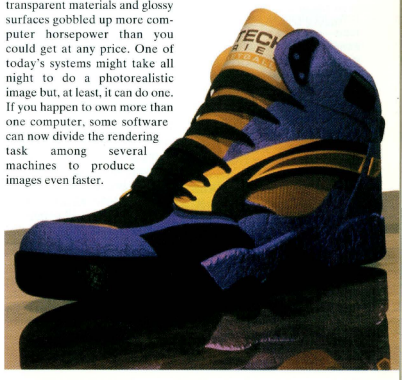
To buy or not to buy and what to buy? When you need to make difficult decisions regarding such a significant investment as CAID, it helps to have a quick reference. That's the purpose of this roundup.

Today, they can smoothly rotate quite complex perspective views of wireframes, even relatively realistic renderings, in real time. Ten years ago, photorealistic renderings were virtually impossible because the ray-tracing software required to depict transparent materials and glossy surfaces gobbled up more computer horsepower than you could get at any price. One of today's systems might take all night to do a photorealistic image but, at least, it can do one. If you happen to own more than one computer, some software can now divide the rendering task among several machines to produce images even faster.

Such progress comes as small consolation for principals of one- or few-person design offices who, nevertheless, cannot afford to graduate from their PC-based systems. For them, this report might serve only to suggest the future of PC-based systems as the line between them and workstation-based systems continues to blur. Providers of high-end software will find it increasingly attractive and compelling to port their UNIX-based software to Macs and PCs, and the broader, more lucrative user bases of these machines.

The Data

Mastering a high-end system requires virtually a full-time commitment, of course. While I have monitored the development of CAID technology for three decades, I don't have time enough to become as expert as my students with even one sys-



Right: Computer Design's DesignConcept 3D software models furniture, apparel, car interiors and other objects characterized by contoured fabric surfaces, rendering them realisitcally as this shoe shows. (Image used with permission of L.A. Gear.)

Left: *Evans & Sutherland's CDRS guarantees that joints between surface segments remain tangent and continuous in curvature whenever the designer changes a section or interactively sculpts the surface by pushing, pulling or twisting it. (This image was developed by Visuals S.p.A., Italy.)*

tem—let alone all available systems—even if I were fortunate enough to have ready access to them. So, I faxed a brief survey form to several vendors of software being used by industrial designers. The accompanying table summarizes the list of basic design features provided by the six who faxed back replies.

Design Features

As the table shows, NURBS (Non-Uniform Rational B-Splines) have become the line-drawing primitives of choice for modeling products. Not merely fashionable, they provide designers with greater scope and flexibility than any other way of generating curved lines and surfaces while maintaining high levels of geometric and aesthetic continuity from one segment of a curve to the next (see CAID Currents, Spring 1992, for more information on continuity, and Winter 1993 for more on NURBS).

Bezier splines come in handy if you are used to designing curves by tweaking tangent vectors with programs like Adobe Illustrator and Aldus Freehand. Some design systems let you import shapes created in Illustrator or Freehand on a Mac or PC as templates or sections for shaping 3-D objects.

I have always advocated solid-modeling (as opposed to surface or wireframe modeling) as the best basis for modeling products. Surface and wireframe models can't truly represent the material substance of a concept; they are abstractions, like pencil lines, that primarily enable us to visualize objects. In effect, they can't hold enough information. Virtually any property or aspect of a concept can be attached as a parameter to a solid model. They can contain information for calculating a product's weight, center of gravity and other mass properties. The computer can perform stress- and mold-flow analyses, without requiring laborious inputs from the user. Solid models also lend themselves best to automated creation of models and prototypes with numerically controlled (NC) shaping equipment.

Rendering Features

All respondents reported that they now feature ray-tracing rendering algorithms. This means that they can model the light rays ricocheting off glossy surfaces and bending through clear materials in order to produce photorealistic renderings. They also produce accurate shadows.

Some systems simplify the ray-tracing process (and shorten it) by computing only one ray bounce. Also called reflection-mapping, this technique reflects a hypothetical environment onto the product's surface to create quite realistic effects. But the technique doesn't render intra-object reflections, like those a knob would cast on a product's glossy fascia.

Ray-tracing soaks up computer horsepower and memory, so you'd only use it for high-stakes "photo" presentations. Mostly, you'd rely on old standbys. Of these, Phong shading is better than Gouraud (pronounced "go-roh") shading because it shades more smoothly and simulates the highlights of glossy surfaces fairly well (but without other reflections).

More vendors now offer texture mapping for "pasting" or "decaling" label designs on bottles and other irregular shapes, or for simulating wood and other materials. Some vendors offer "bump mapping" for, in effect, modeling textured surfaces in 3-D (for more realistic renderings) without actually affecting the database or the model's fundamental surface.

Basic Design Features

A = Alias Research
CD = Computer Design, Inc.
EDS = Electronic Data Systems
ES = Evans & Sutherland
I = Intergraph
PS = Parametric Systems

	A	CD	EDS	ES	I	PS
2-D CAD			■		■	■
B-Splines		■	■	■	■	■
Bezier Splines			■	■		■
NURBS	■	■	■	■	■	■
Solid Modeling			■		■	■

Particular Strengths

Recognizing that all six products shared many of the same features, I asked each respondent to briefly summarize its software's particular strengths when compared with the competition. My even briefer summaries appear below.

Alias Designer has a more powerful NURBS-based modeler that makes free-form surfaces easier to design. Renderings can include the effects of fire, smoke, fog and water. Designers can now sketch designs with a new paint system that simulates conventional media (markers, pastels, etc.) and which accommodates personal rendering techniques. These sketches can then be used as input for developing 3-D models.

Computer Design, Inc. has carved out a special niche with its DesignConcept 3D software for modeling furniture, apparel, car interiors and other objects characterized by contoured fabric surfaces. It then renders them very realistically. Speeding the product development and manufacturing process, it can produce accurate flat patterns from 3-D models for direct transmission to fabric-cutting machinery. Recent improvements include surface continuity across surface segment boundaries. Designers can now change a cross-section in one direction without affecting cross-sections in another.

EDS' Unigraphics software is a fully associative modeling, drafting and computer-aided manufacturing (CAM) system. It incorporates hybrid modeling which combines in a single model the advantages of parametric or variational geometry modeling (see Parametric Technology below); feature-based modeling (where geometric features act as primitive design elements); and solid sculpting. One solid-model database can serve all design, manufacturing and engineering functions across an entire company to promote concurrent product development. EDS also offers software that enables Macs and PCs to function as terminals in a system.

Evans & Sutherland's CDRS (Conceptual Design & Rendering Software) was developed in close cooperation with Ford and Chrysler, so it is well suited to the kinds of free-form surfaces found on cars. It guarantees that joints between surface segments remain tangent and continuous in curvature whenever the designer changes a section or interactively sculpts the surface by pushing, pulling or twisting it. Sections of a surface can be selectively frozen so that changes in adjacent sections don't alter them. Curves lying on a surface, like those defining window openings, can now be edited.

Intergraph's I/Design 3, combining 2-D drafting, 3-D solid-modeling and photorealistic rendering, facilitates concurrent product development by simultaneously linking the work of mechanical and manufacturing engineers, industrial designers and other members of the product development team. Graphic designers can incorporate dimensioned drawings and renderings directly into manuals and other publications with integrated software for page layout, typography and image processing.

Parametric Technology's Pro/Engineer signals an important aspect of CAID's future, "parametric" or "variational" design. The designer builds generic models of components or products that have no specific dimensions. The design is completed by assigning values to the dimensions which causes the model to automatically adjust its proportions accordingly. This means designers will be able to develop a variation of a design by simply giving the computer a different set of dimensions. It also runs on Windows NT, the most advanced operating system for 486- and 586-based IBM-PC compatibles.

Difficult Choices

Unfortunately, you won't find a perfect CAID system, one that does all that you want, as well as you'd like. As the table shows, not all systems even qualify as full-blown CAID systems (with integrated CAD and visualization components). A system with excellent drafting features might have few rendering capabilities. At least two of the most highly regarded visualization systems have no CAD capabilities. Opting for a system based on solid modeling might mean that you forego other features that seem equally important. But, if you wait until a system that has most of the features you want comes along, you might never jump into the CAID stream.

Don't simply opt for the system with the most features. Go for the best mix. Satisfaction with any system stems partly from perceptions and expectations shaped by individual needs and past experience. A car designer obviously needs a different system than a package designer. An experienced user of one system transitioning to another has different predispositions than one who learned on yet a third system. Even Mac users have different expectations and preferences than IBM-PC users when they consider stepping up to an advanced system.

Make Sure You Can Exchange Data

As some industrial designers have, you might opt for two systems, one for CAD and one for rendering especially if you already have amassed lots of experience and files with your current CAD system, or you like it a lot or your most important client uses the same system. If so, you'll need to pass files from one to the other. Most vendors offer translators (not always included in the basic price) for exchanging files. The two most common standards are IGES (Initial Graphics Exchange Standard) and DXF (developed for translating files into the AutoCAD format, virtually the standard for PC-based CAD). San Jose State's industrial design students use IGES to send product designs modeled on Macintoshes to Alias systems for rendering.

In real terms, the costs of advanced systems have plummeted when you take into account how much more performance you get for the dollar from today's workstations and software.

Ideally, you'd like to pass CAD files to the rendering system, and then back to the CAD system after making changes. You should be so lucky! Count yourself fortunate if you get the data to go one way without glitches.

Before settling exclusively for IGES or DXF, ask about custom translators designed especially to pass files between the two systems you prefer. Many exist. The vendor of one system or the other might have developed the one you need because many customers (or an important one) have asked for it.

One brief article based on one brief survey won't tell you all you need to know. Even if you have done lots of research already, you probably have lots more to do before settling on a system. If this article clarifies things at all, or points in the right direction, it will have done its job. ■