Artists and Illustrators Making Use of Computer Graphics

Digital Paint Systems

The development of computer graphics devices as useful tools in non-scientific fields is epitomized by the development of what are commonly known as "paint" systems. There are two primary applications for paint systems in the production of charts and slides, and in making sequences of film or videotape for the entertainment and industrial training industries. The two types of devices are distinguished primarily by the ability of one to output slides or frames of illustrations in a format compatible with television. Either type of system may be used for the other's purpose, though with less convenience than a system specifically designed for one use. This article and the accompanying survey focus upon those systems used in video applications. CGW will continue to track the development of systems (e.g., Dicomed, Comshare Execuchart, Genigraphics, and Xerox) primarily used in static applications. The reader will discover similarities between paint systems in video applications and the pagination systems found in our feature in this issue on the printing industry. The major difference between the two areas is the need of the broadcasting industry to deal with greater numbers of images, but at lower resolution.

The concept of a paint system will not be new to those already familiar with Ivan Sutherland's Ph.D. thesis (Sketchpad) of about 15 years ago. The idea of using a graphics tablet to provide human computer interface has surfaced in a number of fields since Sutherland's original work at MIT, but its uses in cinema, video, and broadcasting are perhaps the most visually pleasing and well known. The prospect of freeing artists and illustrators from the tediously limiting tools of their art—ink, pens, and paper—is tempered by the limitations and cost of the current generation of paint systems. The recent withdrawal of the Ampex's AVA from the marketplace, for instance, demonstrates that even technological excellence may not be rewarded with patronage in recessionary times. There are, however, other benefits that will insure the continued growth of digital art systems.

The advertising industry has a well-earned reputation for developing and overusing promotional techniques. The application of graphics technologies in advertising has become one of the most fertile areas for new production methods during the past five years. Proof of this can be found in the extraordinary number of awards given for advertisements that have used effects created by computer graphics. Such publicized effectiveness in promotional communication is likely to increase the demand for computer graphics in advertising, and part of that demand will necessitate better artist/illustrator interface with computers.

Demand for computer graphics is also found in those segments of the broadcasting industry dealing with news, sports, and weather—all of which need high-quality graphics that can be economically produced in a short period of time. The needs of each of the three areas are similar in some respects (e.g., a need for diagrams for the news, and maps for the weather). CBS, in particular, has engaged in a long-standing ef-

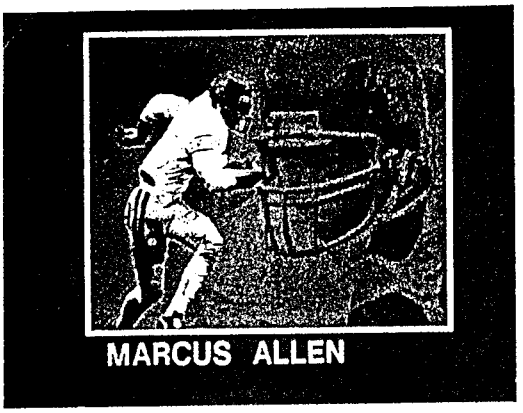

Figure 1 A sports illustration scanned into and manipulated on the Aurora Imaging System.

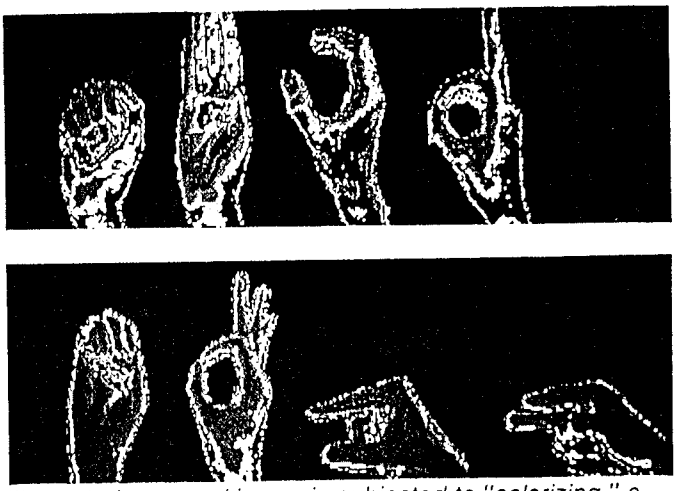

Figure 2 A scanned image is subjected to "colorizing," a digital video special effects.

DIGITAL PAINT SYSTEMS SURVEY

Manufacturer Model	Aurora Digital Video Graphics Systems	Aztek Model 20 & 30 Graphic Systems	Chyron Chyron IV Plus	Datamax UV-1	Digital Effects Video Palette III
System Configuration	DEC LSI 11/23; 15"×15" tablet; 20" RGB monitor for display; 20" color monitor for menu	H-P 1000; H-P tablet 15"×15"; Lexidata frame buffer; Mitsubishi 1000 monitor	Proprietary CPU; 14"×14" tablet; keyboard; digitizing camera	Z-80 microprocessor; 11"×11" tablet	Digital Equipment Corp. 11/34; Lexidata 3400 frame buffer; 11"×11" tablet; 19" Conrac color display monitor
Resolution	512 × 486	480 × 640; 1024 × 1280 in two configurations	264 × 144 in background; foreground is run-length encoded	525 lines	512 × 512
Character Generation	2 fonts available; user may design unique fonts	User-definable character set; 14 fonts in system plus custom fonts	50-font library available	8 fonts available; user may design fonts	N/A
Animation Capabilities	Color cycling; auto sequencing	Color cycling and sequencing	Sequencing	"Real-time" animation; color cycling; sequencing	Color cycling; auto sequencing frame-at-a-time onto a Dicomed
Colors in Palette/Display	32/256	4096/256 or 256/16	512/16; 64 for edges; 1 per character; 7 per logo	256/4, 8 or 16 depending on use	16 million/256
Brush/Paint	Artist designatable brushes, 8 storable on menu, no limit on the number available	1 to 100 pixels in 10-increment levels	4 to 6 widths available	User may designate brushes	Artist designated brushes, up to 500 storable; no limits on the brushes; standard set of symbols
Image Library	10 to 20 images on disc	256k-byte internal memory	One internal	24 bit store, can be divided into 12, 2-bit planes	One internal in buffer
Price	$115,000 to $200,000	$75,000 & $98,000	$79,000; tablet addition, $1,000	$6,595	$125,000
Special Features	Different storage capacities available; other options for output	Can support 4 additional work stations; 12 low-cost stations; video digitizer; compatible with all camera systems	Newly designed station provides separate image display monitors to be combined in boolean fashion; new text can be read onto screen continuously		Interface for film, video or both; photo-digitization option; custom software development
Remarks	**Aurora Imaging Systems** Richard Shoup 185 Berry Street San Francisco, CA 94107 (415) 777-2288	**Aztek Data Systems** Phil Lippencott 23265 South Pointe Drive Laguna Hills, CA 92653 (714) 770-8406	**Chyron** David Bucker 265 Spagnole Road Melville, NY 11747 (515) 694-7137	**Datamax, Inc.** 2256-B Landmeir Road Elk Grove Village, IL 60007 (312) 981-8205	**Digital Effects, Inc.** Judson Rosebush 321 West 44th Street New York, NY (212) 581-7760

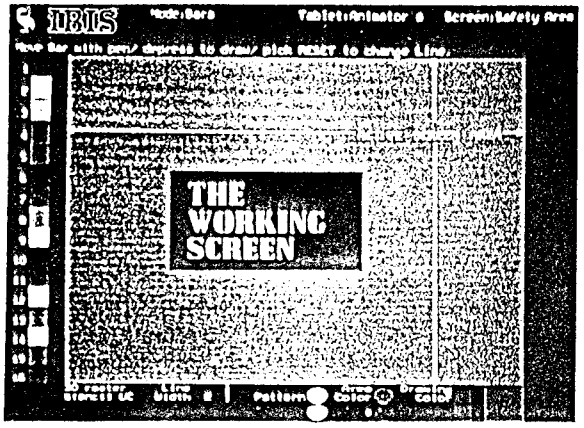

Figure 3 The working screen, including color palette from Morgan-Fairchild's IBIS system.

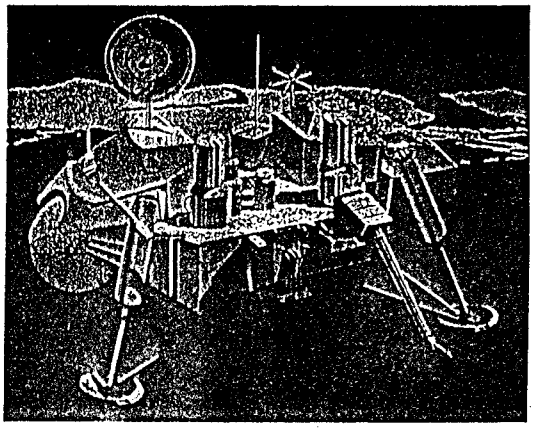

Figure 4 Display of the manned moon lander produced on Logica's Flair system.

Dubner CBG-2	**For-A-Corp** FVW-910	**Gravitronics** GDS	**Interand** Telestrator Electronic Graphics System	**LogE/Interpretation Systems** VIEW	**Logica** Flair
8080 Intel, 2901 bitslice processor; 11"×11", or 15"×15" tablet; monochrome menu monitor; 2 output ports for color signals	Z-80 microprocessor; lightpen; direct palette to device interface	CPU-Data General — Eclipse/Nova; Ramtek 6000, AED 512, or Ramtek 9400 (6K, to 12K, to 25K) s; tablet — 36"×48" or custom	Multiple microprocessors; proprietary frame buffer	DEC LSI 11/23; trackball/function key cursor manipulation; interface to tablet available; RGB 19" monitor; monochrome monitor	Intel 8085 microprocessor: 16"×12" article; 20" RGB monitor
525 × 1024	384 × 224 (NTSC); 384 × 256 (PAL)	512 × 512; 1280 × 1024	512 × 512 to 4096 × 1600 on different systems	512 × 512 or 1024 × 1024	785 × 575
User may design fonts; all lettraset fonts may be used	None	User can design fonts; 3 fonts internal; custom fonts available	Fonts can be designed; systems have different character set capabilities	One character set in 4 sizes; user may design character fonts	1 font in 3 sizes; user may designate fonts
Sequencing at 60 frames per second	None	Color cycling; plane switching/reveal	Sequencing; color cycling	Color cycling, sequencing	Color cycling
512/64	7/7	64/16 to 4 million/256	64 to 4096	16 million/4096	16 million/256
User-designatable brushes	2 brushes; 1- and 3-pixel widths	1 to 5 pixel width; user can designate other brushes	N/A	Cursor with 1 pixel line or window brush; 2×2 pixels to screen width	Brushes designatable by user; standard widths
2 images internal	One image internal	32 bit store; different planes within 32 bits	3 in internal memory	4 images internal	1 internal
$76,000 to $100,000	$6,500 to $7,100	$40,000 to $80,000	$12,000 to $60,000	$80,000	$80,000 to $90,000
	N/A		Model 100 — for sports/weather/news; Model 440 — for more color, logos, better image store; Model 880 "Magician" — for video fine art	N/A	Menu on tablet; mirror imaging; overlay function
			Patents pending on display technology		
Dubner Computer Systems Inc. Harvey Dubner 158 Lindwood Plaza Fort Lee, NJ 07024 (201) 592-6500	**For-A-Corp** T. Hitota 1680 North Vine Street Suite 201 Los Angeles, CA 90028 (213) 467-8412	**Gravitronics** Wolfgang Baer 3014 Shattuck Avenue Berkeley, CA 94705 (415) 644-2230	**Interand Corp** Erik Lunkenheimer 666 North Lakeshore Drive Chicago, IL 60611 (312) 943-1200	**LogE/Interpretation Systems Inc.** Richard Pendergrass 6322 College Blvd. Overland Park, KS 66211 (913) 642-8700	**Logica, Inc.** Richard Veith 666 Third Ave. New York, NY 10017 (212) 599-0828

Figure 5 A typical advertisement application of the Spectra digital paint system.

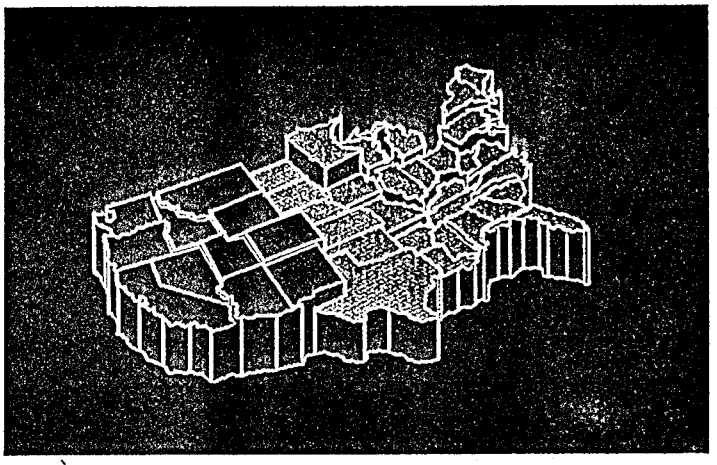

Figure 6 A business application of the LogE Compuslide system.

DIGITAL PAINT SYSTEMS SURVEY

Manufacturer Model	McInnis-Skinner Weather Graphics	Morgan-Fairchild IBIS	Norpak IPS-2	Northern Telcom VIPS	NYIT IMAGES
System Configuration	Hewlett-Packard 1000 minicomputer; monochrome menu monitor; Genisco color raster display, GCT-3000; 17"×17" tablet; 12" color monitor	Ramtek 6214 color terminal; 11"×11" tablet	Manufacturer-designed console; DEC, LSI 11/03; 13" RGB monitor; 13" monochrome menu monitor; optional tablet	Cromemco 3; monochrome menu monitor; color, RGB electro-chrome display monitor; tablets — capacitance/or pressure sensitive	DEC PDP 11/23; Genisco/NYIT frame buffer; 14"×14" tablet; 12" monochrome monitor; 19" RGB monitor
Resolution	640 × 480	640 × 480	200 × 256	256 × 256	512 × 487
Character Generation	Univers; Helvetica; Futura; other lettraset fonts; user may design fonts	5 fonts available (Helvetica, comtina, stencil); user may design fonts	2 sizes of font internal; user may design fonts	None	20 fonts available
Animation Capabilities	Color cycling; sequencing	Color cycling; sequencing	Page cycling for animation effect	None	Color cycling; sequencing; replay of previously designed frames
Colors In Palette/Display	4096/256	64/16	16/16; 6 colors, 8 grey shades, B&W	4069/16	16 million/256
Brush/Paint	User may design any width brushes; up to 1500 symbols/ brushes may be stored	3 brush types — straight lines, 1 to 32 pixel brush width; line duplication function "polyline"	User can designate "brushes"; standard brushes are circles, lines, polygons	Line drawing for entry of geometric primitives; no "brushes" as in other systems	Artist may designate unique brushes; up to 50 may be stored in system
Image Library	8 images internal	1 internal; up to 20 images per disk	1 frame internal		10-byte internal memory; 1 image in frame store
Price	$68,700	Software $15,000; hardware $28,000	$17,500; tablet $1,800	$18,000 to $24,000	$105,000
Special Features	N/A	N/A	Text editing; mini-data base	Built-in modem with automatic dialer for videotex	Paint mode allows designer to exceed resolution of display device; animator software; special effects software
Remarks			One of two paint systems used for Telidon	System used for Telidon page creation	
	McInnis-Skinner Ron Hudson 6529 Classen Blvd. Oklahoma, Blvd, OK 73166 (405) 848-4246	**Morgan-Fairchild** Emeline Matthews 4224-A University Way N.E. P.O. Box 5475 Seattle, WA 98105 (206) 632-1374	**Norpak Ltd.** Ian Hembry 10 Hearst Way Kanata, Ontario K2L 2P4 Canada (613) 592-4164	**Northern Telcom** John Yeomans 33 City Center Drive Missisauga, Ontario L5B 2N5 Canada (416) 275-0960	**NYIT Computer Labs Inc.** Marco Cardamone 405 Lexington Ave, 59th Fl. New York, NY 10023 (212) 399-8398

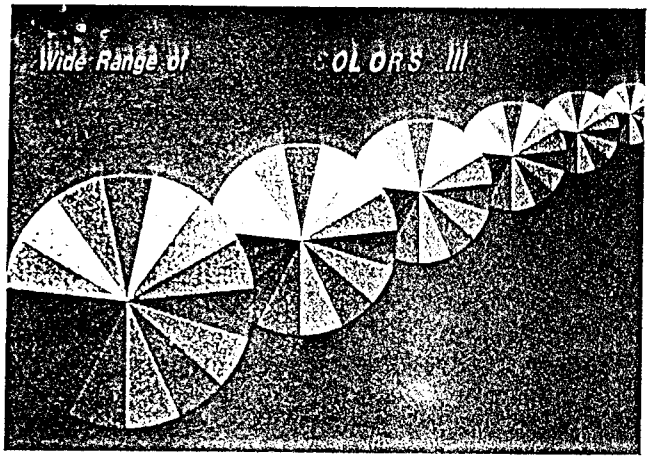

Figure 7 Color wheels produced on the Aztek system, demonstrating its brush duplication feature.

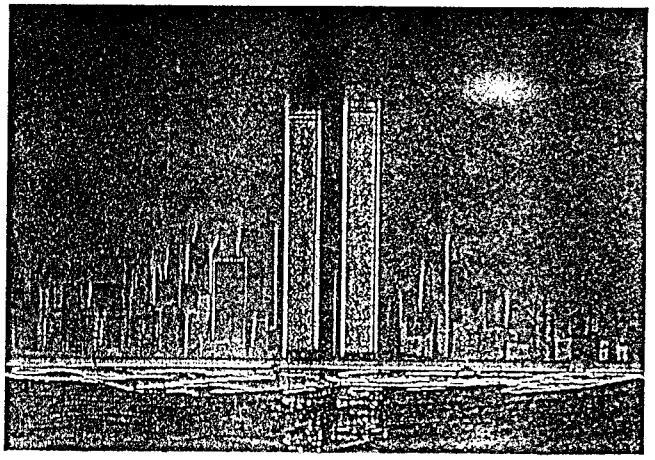

Figure 8 Manhattan Skyline produced on Digital Effects Video Palette III, artist, Mark Lindquist.

Ramtek-Xiphias Videograph	**Research Machine** 380Z Jackson	**Spectra Computer Systems** S1010 Digital Art/ Paint System	**Via Video** System One	**Vidifont Graphics V** Thompson CSF	**Weathermation** System II
Z-80A micro; Ramtek 6214 color terminal; 15"×15" tablet; 13" RGB menu/display monitor	Z80 microprocessor; joystick; 12" RGB monitor; dual floppy-disk drive	Chromatics CG series bases; 15"×15" tablet; 15" RGB monitor; HD 1010 disk drive	Z80-based console; 15"×15" tablet; 9" monochrome monitor, 13" color monitor; camera digitizer	Multiple 6809 microprocessors; 11"×11" tablet; 19" color display monitor	Multiple Z-80 processors; 11"×11" tablet; 12" monochrome menu monitor
640 × 512	625 × 480	512 × 512	756 × 484	512 × 1088	640 × 480
Helvetica, Futura plus 8 other fonts; user can design fonts	1 set available; user may design set	Any lettraset font is producible; user may design fonts	5 fonts in system; all lettraset fonts can be digitized	User can design fonts; custom fonts provided	User can design fonts
Color cycling; sequencing	In-betweening	Sequencing	Color cycling; sequencing	Color cycling; sequencing; scaling of figures	Color cycling; sequencing
64/16	256/11	80/80	4096/16	4096/64	256/16
Brush 1 to 128 pixels in width; 1536 storable symbols in a number of menus; custom brushes designatable	User designatable from 1 to 300 pixels	1 to 5 pixel widths; artist may design brushes	16 sizes, 1 pixel to many pixels	1 to 12 pixel width; artist may designate brushes	N/A
Internal image store holds 2	32k or 56k RAM	1 image internal	½ megabyte internal memory	2 frames internal	1 frame
$50,000 or less	$13,000	$80,000	$35,000 to $60,000	$68,500	$27,000 for radar display; $36,000 for graphics; $47,000 for both
Menu prompting; online help files	Operates on PAL (625 lines) and UK voltage	NTSC output; interfaces to weather services for radar map	Direct video output; 7 picture planes allow 7 images to be overlaid at once	NTSC/PAL/RGB output; mirroring	Accesses national weather service or uses radar display
Xiphias Peter Black 233 Wilshire Blvd. Suite 900 Santa Monica, CA 90401 (213) 399-3283	**Royal College of Art** Computer Art Bryan Smith London SW 7 United Kingdom 01-584-5020	**John Welland** 391 Chipeta Way Research Park Salt Lake City, UT 84108 (801) 581-5478	**Via Video** Matt Blum 10115 S. DeAnza Blvd. Cupertino, CA 95014 (408) 996-2055	**Thompson CSF-Broadcast** Thomas Hindle 37 Brown House Road Stanford, CT 06902 (203) 327-7700	**Weathermation Graphics Inc.** Bill Smith 190 N. State Street Chicago, IL 60601 (312) 263-6921

fort to enhance its broadcasts with clear and entertaining graphics. This has necessitated maintaining a staff of highly-talented illustrators and designers who can be called on to create materials as needed.

Because of the nature of the news today—being global in its coverage and having a multiplicity of topics—the demands for graphics are continuously changing. A minor topic in one newscast may become a major news item within a short period of time, and require major illustrative supplementation. Thus, the ability to quickly produce graphics that can convey complex subject matter becomes crucial to effective communication.

Another need relates to the intense competitiveness that characterizes coverage. As news programs have become a major source of income for the networks, graphics that can attract and hold viewer attention have become a paramount concern. CBS responded to these concerns by gathering some of the most capable graphics illustrators available, and by building a well-indexed library of graphics (both paper and digital disk-stored) that it could use for broadcasts or take apart for utilization in the design of new materials. Maps and photographs are two graphics that lend themselves to efficiencies in storage and reuse. As increased demand in the marketplace and lower equipment costs caused continued introduction of digital technology into broadcasting, a group of developing technologies from Xerox and Bell Research Laboratories came to the attention of CBS. It was CBS that provided the commercial impetus and widespread introduction of paint systems into broadcasting.

Much earlier, Richard Shoup had been asked to participate in the establishment of Xerox's Palo Alto Research Laboratories by becoming a resident scientist. While at Carnegie Mellon University, Shoup had been exposed to the work of Leo Harrison who had developed analog computers for use in video—long before digital techniques were suitable for video applications. It was this that inspired his efforts to build a digital video system. He was to spend nearly nine years developing what have come to be known as digital paint systems. One of his colleagues at Xerox, Alvery Ray Smith, later helped to develop the computer graphics laboratory at the New York Institute of Technology (NYIT), which now markets its own paint system (the basis for Ampex's AVA).

It was Shoup who personally built one of the first digital frame buffers to support the Xerox system, and by 1973 the system itself was operational. Similar work had produced a system at Bell Laboratories under the guidance of Knowlton and Miller, and at MIT. Shoup's system, called "Superpaint" at Xerox, gained its reputation through two applications—one for a California television series called "Over Easy," and the other to illustrate NASA's Venus flights. As Shoup's ability to design a system began to outgrow the limits of research at Xerox, he formed a partnership with artist Damon Rarey and started Aurora Imaging Systems. Already referred to by many as the "father" of paint systems, it was Shoup's work at Aurora that produced one of the most facile menu-operated systems on the market.

Shoup has outlined for Computer Graphics World, the principles of design that have guided his development of a paint system, or as he calls it a "video-graphics" system. Foremost among his opinions (and reflected in this issue's articles by Lansdowne and Watkins) is that the system is a tool for artists. Artists, generally, know little about computers and cannot be constrained by a machine's limitations if tight-production deadlines are to be met. Fortunately, the Aurora system has multiple monitors that allows the artist to view both the menu and the art. The menu itself is entirely graphical, allowing the artists to forego interacting with a keyboard for all but the system's initialization.

Another important feature is the interactivity of the system, which to Shoup means its capacity for real-time animation. There are a number of methods used by paint systems to create animation, at least one of which (color cycling) was developed and popularized by Shoup. In simple terms, color cycling means that a color table is used to assign (most often at random) different colors to specific pixels, giving a design the appearance of movement. This "color cycling" is used to achieve a number of effects such as stepwise motion and "reveal" animation.

A well-known animation effect of some paint systems is "history" playback (history files record the actions entered into the processing file of a computer). In this technique, an artist can create an object through a number of steps. For instance, having entered the command sequence for the creation of a tree, the commands could be replayed in rapid sequence—presenting the visual effect of animating the creation of the tree. Some animation work, such as that at Ohio State University, is accomplished through replaying stored images on hard disk. Frames of images are continually set up in the frame buffer, and displayed.

The third technique, used to create filmed-animation sequences with paint systems, is to interface a camera (e.g., a Dicomed or Celco film recorder) or video tape recorder with the system. The individual frames are then recorded as they are created. Recently, magnetic video disks have become available that are capable of recording these individual frames. However, their cost and limited storage ability prevent widespread use.

Real-time generation of animation is used in the simulation industry to produce massive amounts of imagery, but at substantially lower resolution. The need for resolution, however, may vary from one application to another. In some cases, an Apple computer may suffice, but for

most broadcasting and advertising applications high quality is required. This means that anti-aliasing or filtering techniques must be applied to images before they can be used.

One final aspect of system design mentioned by Dr. Shoup is the need to provide flexible configurations. Most important, is the ability to provide multiple-access terminals to the computer's memory. In a broadcasting environment, for example, it might be desirable to provide access to the system in an editorial suite for review purposes. One might also want a system that allows for multiple users through terminals and memory additions.

In compiling the information for the accompanying survey, several important controversial aspects of paint systems became evident. One of the most prominent of these is the description given to system paint or brush methods. Basically, the term brush is used to describe the user's ability to paint on the CRT in color. The term is appropros because of the physical similarity between a paint brush and a tablet wand when the wand is used to apply color to the CRT. There are two distinctive types of tablet interfaces for paint systems: Capacitance systems that may only duplicate a color that is assigned to them, and pressure-sensitive tablets that produce different saturations of color—depending upon the artist's brush pressure. One user lamented a manufacturer's attempts to describe a system as having the qualities of an airbrush. His feeling is that electronic brushes are in no way comparable with airbrushes, and that manufacturers are deliberately misleading purchasers with such claims. The ability of a user to create unique brushes appears to be the most important consideration, along with the availability of different brush widths.

There are widely varying opinions as to the range of colors needed in paint systems. One side says that the artist needs to have a system that will allow as wide a creative range as would be available through additional means, while the other points out that since television displays have a practical limit of 32 colors, that the 16 million-color capacity described by manufacturers with 8-bit pixel depth is largely superfluous. One system-developer has remarked that these colors cannot be broadcast by or recorded on standard television—a point that would seem to support those who describe the millions of colors as a market promotion. While there is probably no definitive answer to this question, one can appreciate the creative needs of artists and illustrators who want to be able to blend and mix their colors to achieve specific effects.

Most systems allow original art work or backgrounds to be scanned directly into the display image or the frame buffer (see *Figure 1*). This underscores the efficiencies introduced through the use of digital-input technologies. There is an enormous body of existing artwork, available to designers through video digitization, that can be suitably manipulated for specific purposes. The digital frame store provides a function similar to the artist's canvas. Video signals can be sent to this "canvas" from the graphics tablet or a digital-storage medium. The advantage of the frame store is that it provides the artists with pixel memory in which color planes may be stored and manipulated. Once in the frame store, an artist may subject the image to a vast repetoire of digital effects that are widely used in the video industry—e.g., flipping, replication, compression, and colorizing (see *Figure 2*).

Systems considered in the accompanying survey are primarily menu based, and almost all of them have a number of similar features. Most common of these is the use of "fill" algorithms to allow polygonal spaces to be filled by an operator-designed color. Method and speed of filling may differ from one system to the next, depending upon the formula used. Most of the systems have the capacity to produce RS-170 video composite and NTSC signals. Some produce RS-232 signals for computer-to-computer communications, or for communication between multiple monitors within a system. Some of the more advanced systems have truly unique features. The MCI/Quantel digital fine art system (not included in the survey due to the unavailability of technical specifications) has a color recognition capability similar to that found in advanced pagination systems. This capability allows the artist to assign to the cursor controller any color already present in the display, greatly enhancing the designer's ability to touch-up parts of the image. IMAGES, the NYIT-produced system, has the capacity to produce the effect of multiplanar animation cameras — with several planes available for overlay. Others, such as Logica's Flair, feature commands that allow the artist to split the screen and duplicate the display in a "mirror" fashion. The Weathermation system, originally developed to provide weather graphics, has since expanded into other areas. Two of these systems can interface with output from the National Weather Service to display their radar scans. Finally there are two systems that are used to produce Telidon images. Both appear to be relatively simple, due to their need to produce displays that are suitable for transmission over telephone lines.

As the use of electronic media for communication increases, we can expect further development in digital paint or digital fine art systems. The lesson of AVA has not been lost, and we are likely to see systems designed that will fill specific market niches. We are also likely to see different disciplines (e.g., publishing, animation, and computer-aided design) borrowing techniques from one another in order to resolve present system limitations. ■

Jerry Borrell