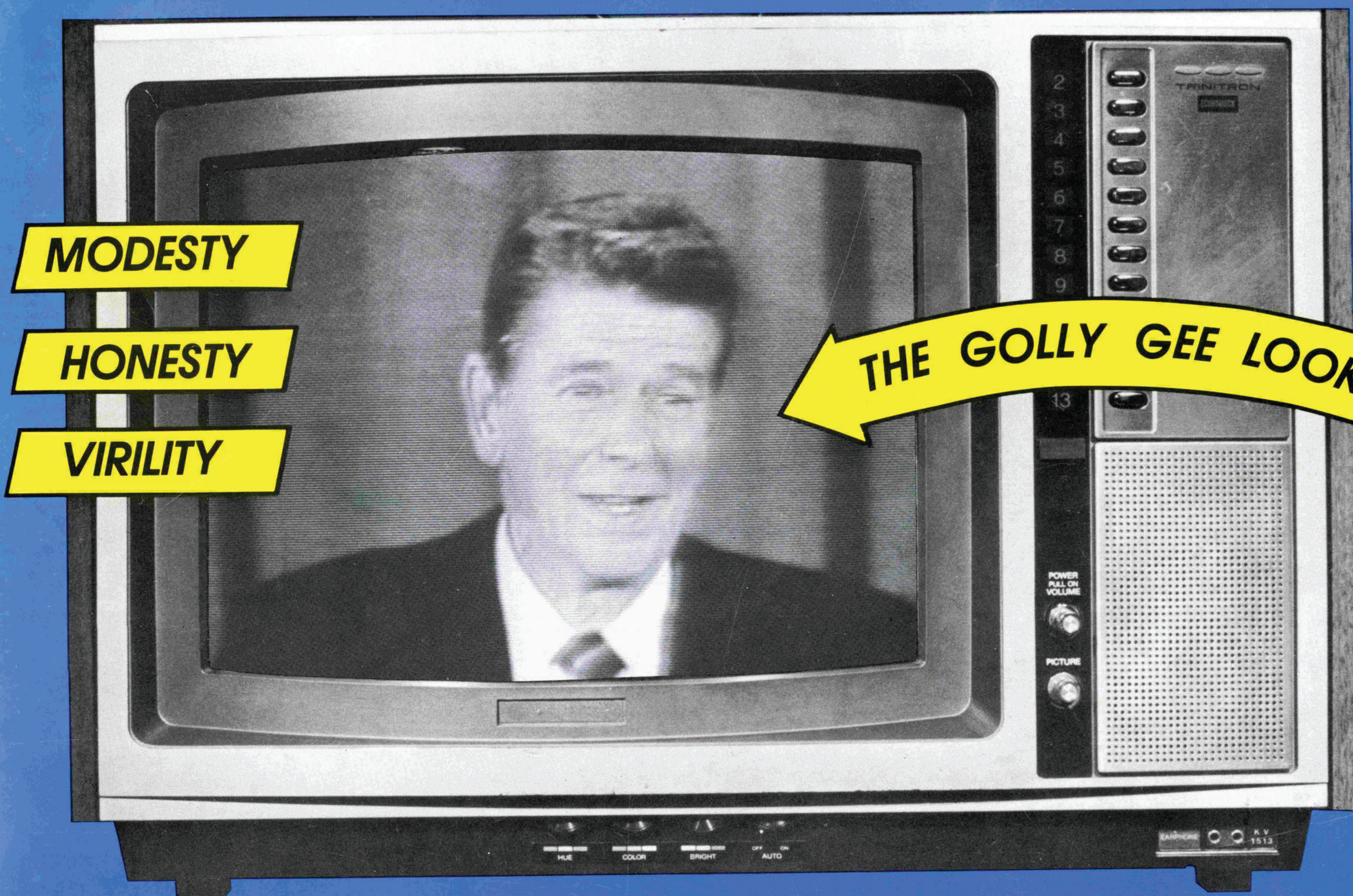
VIDEO 80

MAGAZINE

ISSUE #4

PRICE $4.00



RONALD REAGAN

THE POLITICS OF IMAGE

BY

DOUG HALL

COMPUTER ANIMATION

A PRIMER

BY

LARRY CUBA

NAM JUNE PAIK

EXCLUSIVE INTERVIEW

by

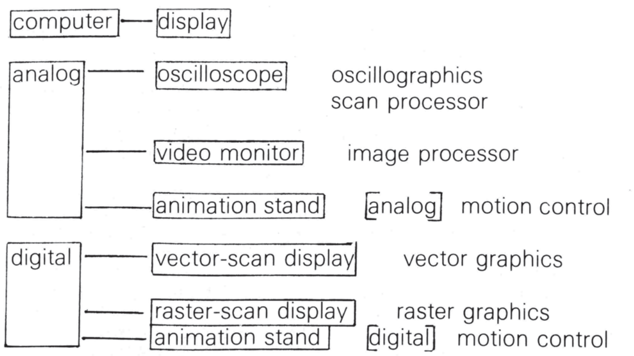
WILLOUGHBY SHARP

SPECIAL ISSUE:

ART & COMMUNICATION

An Introduction Computer Animation

by Larry Cuba



OVERVIEW OF SEVEN COMPUTER ANIMATION SYSTEMS

Figure 1

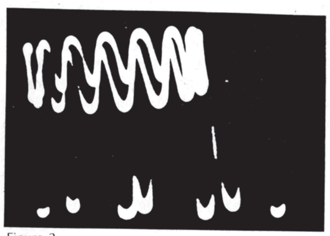


Figure 2

COMPUTER GRAPHICS IN MOTION

Computer animation has been in development and use for years, but only recently has become a common feature of our visual world. We see it in movies, TV commercials and video games.

There are hundreds of computer animation techniques just as there are hundreds of ways to make music. To help understand these techniques, we can group the computer animation systems into categories, just as musical instruments are grouped into woodwinds, strings, percussion and brass.

In this article we will discuss seven generic systems as illustrated in Figure 1.

All the computer animation systems that we will look at are composed of at least two component parts: the computer and a drawing device. The drawing device makes the images which are photographed onto film or videotaped. The computer controls the drawing process by sending the device electronic signals, and the artist controls the computer.

There are two kinds of computers: Analog and Digital. Usually when we use the word *computer*, we're talking about digital computers. These are the ones that send out utility bills and run video games.

Few people have even heard of analog computers, because when we encounter one, it's called something other than a computer. An electronic musical synthesizer, for example, is actually an analog computer.

Since the machine is not usually called a computer, calling the work produced with it *computer animation* has led to a confusion betwen analog and digital work. Rather than argue the semantics of the term 'computer animation,' we'll consider techniques based on both kinds of computers.

PART 1—ANALOG SYSTEMS

1. OSCILLOGRAPHICS

Analog computers were being used by artists to make films as early as the 1950s. Figure 2 is from a film by Hy Hirsch. The system used to create this film consists of an analog computer and an oscilloscope, and the technique is called oscillographics.

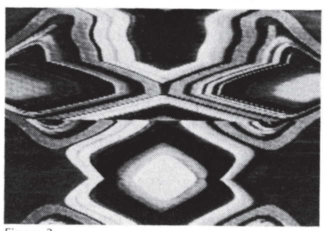


Figure 3

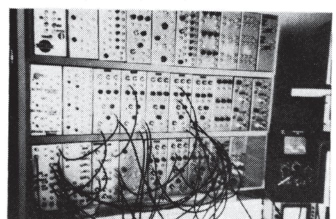


Figure 4

An oscilloscope is a screen and a beam of electrons which hits the screen and draws a point of light. The point of light can be controlled in three ways. The beam's position is controlled by turning 2 knobs, one for Horizontal movement and one for Vertical movement. A third knob controls the Intensity of the beam, and consequently the brightness of the point on the screen.

Instead of using knobs, we can attach wires to these functions and control them by changing the voltage in the wire. Thus, the amount of voltage flowing in the wire substitutes for the 'position' of the knob, and determines the position of the beam.

The position of the beam is *analogous* to the amount of voltage in the wire. That's why this is called an analog system. In digital systems, numbers are used to specify the position of the beam rather than voltage levels. The pattern of voltage channels in the wire is called an electronic signal.

So the problem of making drawings on an oscilloscope is a matter of generating electronic signals. This can be accomplished with an electronic music synthesizer. The classic music synthesizer (such as Moog, Buchla or Arp) is an analog computer.

The film or video artist creates animating images on the scope by generating signals with the music synthesizer and using them to control the movement of the beam.

This process of composing an electronic signal by patching modules together with cables is used on all analog systems. The differences are in how that signal is used to make an image.

2. IMAGE PROCESSOR

By generating two independent signals and using them to control the vertical and horizontal movements, a pattern can be formed which completely fills the screen from top to bottom with horizontal lines. This is the scanning pattern used in video and the pattern is called Raster scan.

A television picture tube is similar to an oscilloscope except that the horizontal and vertical motion is fixed in such a way so that the beam is constantly scanning out a raster pattern. If the horizontal and vertical movements are fixed, then that leaves only the Intensity signal to form the image.

Variations in the beam's intensity during the scan produces an image composed of various shades of grey. The levels of grey in the image range from black to white and correspond to the range of possible intensity levels.

If we use signals generated with a synthesizer to control the intensity, then variations in the voltage level of the signal will result in variations in grey level. This is how a video synthesizer forms an image. The image in Figure 3 is from *Electronic Masks* by Barbara Sykes and was produced with the Sandin Image Processor (Figure 4).

3. SCAN PROCESSOR

The next analog system we'll discuss is the scan processor. Video artist Woody Vasulka used a scan processor to produce the image in Figure 5. A scan processor, like the music synthesizer system, uses an oscilloscope-like display.

Figure 5

In a scan processor, the raster is scanned as in video, but unlike standard video, the pattern can be modified by the user. Any of the three signals forming the raster pattern (vertical movement, horizontal movement, and intensity) can be modified. These modifications can come from either synthesized signals or a video camera.

In both of the video synthesizers we've looked at, image processors and scan processors, signals could be generated internally or with video cameras.

An image processor is designed to process the image as encoded in the standard video signal (that is, the intensity signal only). A scan processor, on the other hand, can actually alter the scanning pattern itself (that is, it can modify the horizontal and vertical movements of the beam).

If the scanning pattern is modified, then the result is no longer a standard video signal. (So, it can't be fed directly to a TV or tape recorded.) The results appear on an oscilloscope-like display and so scan processors belong with oscillographics on our chart (Figure 1). And just like oscillographics, to be recorded the screen must be filmed or rescanned with a video camera.

If rescanned with a video camera, then a video signal is created which can be processed with an image processor. So you could produce an image on a scan processor and process it and colorize it on an image processor.

These two functions are combined in a single system called the *Scanimate,* which was developed by Lee Harrison in the late 60's. Ron Hays used a Scanimate system to create his videotape *Canon* (Figure 6).

REAL TIME VS. CONVENTIONAL ANIMATION

In the systems covered so far, we've seen analog computers used to generate and process electronic signals. These signals were used to drive two types of displays: oscilloscopes and video monitors. With each of these two displays we could see the images moving on the screen in front of us. This display could then be filmed or videotaped like a live action scene. Should we call this animation, though?

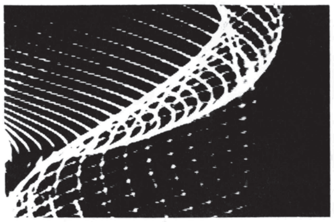


Figure 6

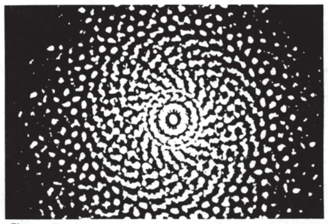


Figure 7

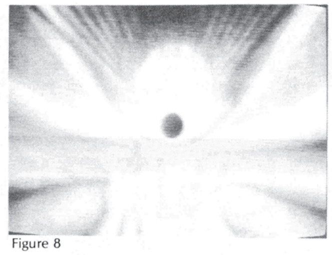


Figure 8

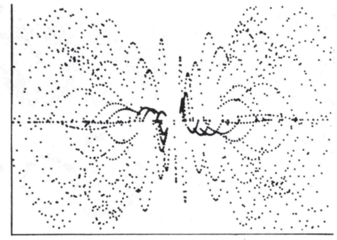


Figure 9

In any film, what we see as a moving image is really a series of stills projected in sequence at great speed: 24 per second. In live action, those stills were created by the camera capturing a series of snapshots of the constantly changing real world at the same speed as projection: 24 per second.

In conventional animation, each of these stills is a photograph of a drawing. The drawings are placed on an animation stand and photographed, one at a time. When projected back at 24 frames a second, movement is synthesized. Film is the mechanism which allows us to project at great speed drawings which were created and photographed at slow speed (or one at a time).

In contrast to conventional animation, the systems we've looked at so far create and display the sequence of images at high speed so movement is visible directly on the display.

This is called Real Time Animation. The sequence of images is being produced and displayed at a speed which produces the illusion of movement. This eliminates the need for film as the mechanism of animation. Once a sequence of images is visible on the screen, then either film or video can be used to capture it at live action speed.

VIDEO ANIMATION

In conventional frame-at-a-time animation, the recording medium must be capable of recording in a still-frame mode.

This is easy for a film camera, hard for a videotape recorder. So animation has traditionally been made on film. More recently, single frame videotape recording has been developed, making "video animation" possible.

But this "video animation" has been confused with work produced on a video synthesizer, which has also been called "video animation." In one case, you have video record single frames, so you can shoot drawings with it, and in the other, you use video technology to synthesize animating images in real time.

4. ANALOG MOTION CONTROL

The movement in conventional animation comes from two sources:

1) changes in the image from one drawing to the next, and
2) slight movements of the stand between exposures to animate pans and zooms. These stand movements can be automated and controlled with computers, and since these movements alone can create animation, the animation stand can be considered a drawing device. (see Figure 1) This technique is called Motion Control.

Analog computers, because of their speed, have an advantage over digitial computers when it comes to generating real time animation.

But for motion control, which is frame-at-a-time animation, you're better off with digital computers because of their many other advantages. And today's motion control systems are all digital. Still, the first motion controlled stand used an analog computer. It was called The Whitney Cam Machine. Motion Control techniques opened the door to a whole new world of special effects magic in Hollywood. When the movie *Star Wars* came out in 1977, it started a science fiction craze in Hollywood feature films with dazzling effects like the jump into "hyperspace."

This jump into "hyperspace" effect is called a streak, and was invented by John Whitney, Sr., who invented motion control in the 1950's by building the first computer-controlled animation stand in his garage with an army surplus analog computer.

The analog computer controls the movement of the artwork which is back lit on a light table. The film camera looks down from above and photographs the artwork as it moves. The principles of the Whitney Cam Machine were copied in machines that Doug Trumball built for the *2001* stargate corridor sequence, the ones Bob Abel built to make TV commercials, and the one John Dykstra built for *Star Wars.* Since *Star Wars,* motion control has blossomed into an industry standard, but now all systems are controlled with digital computers. We'll see them shortly in Part 2 on Digital Computers.

WHITNEY CAM MACHINE

The control mechanisms have advanced and become quite elaborate since motion control was invented, but the basic vocabulary of effects was established on the Whitney Cam Machine:

1) multiple exposures,
2) streaks, and
3) slitscan.

One benefit of motion control is the precise repeatability of animation stand movements. This ability can be used to produce multiple exposures. If, while the shutter is open, an object that emits light is moved into several positions and its light turned on, then multiple images of the object will appear on the film.

This principle is applied to animation in motion control: on an animation stand, artwork can be lit from behind. When the artwork is moved around in a circle and the lights flashed several times during the exposure, a multiple image is created. This is the technique used by James Whitney (John's brother) to produce the film *Lapis.* (Figure 7)

Another way to use motion control is to leave the lights on while the artwork is moving. This creates a time exposure effect like a photograph of car headlights whose movements are visible as a streak of light. A film, *Terminal Self*, consisting entirely of streaks was made by John's son, John Whitney, Jr.

This streak effect has often been mistakenly called slitscan, but streak and slitscan are two totally different effects. The only thing they have in common is that they are both time exposures. Slitscan is a 3rd technique developed on the Whitney Cam Machine. In slitscan, the artwork is not seen by the camera lens all at once. The artwork is completely covered except for a sliver revealed through a narrow vertical slit in the covering. While the camera shutter is open for a time exposure the slit moves across the artwork and reveals it progressively to the camera which records an image on film.

If, during the exposure, there is no movement of the artwork or the camera but only the slit, then the art appears on the film as it would without the scanning slit, i.e. normal. However, if while the slit is scanning across the artwork the camera zooms in toward it, then a distortion is introduced: a bulge is produced in the figure. For example, a rectangle is transformed into a trapezoid.

These three elements of the basic vocabulary of the Whitney Cam Machine can be found in the later (and current) crop of motion controlled animation stands that use digital computers.

PART 2 - DIGITAL SYSTEMS

For each of the 4 types of analog animation systems we have covered, there was a different KIND of analog computer. One was a Scan processor, another was an Image processor, and so on.

We'll look at several digital animation systems, but only one kind of digital computer. That's because all digital computers do the same thing fundamentally: they follow lists of instruction and can store these lists (and other data) internally.

The major variations among digital computers are:
1) the speed at which they operate, and
2) the size of their internal storage. These are usually a function of the size, cost, and age of the computer.

What distinguishes the digital animation systems on our chart in Figure 1 is the type of display. We'll consider three different kinds (vector, raster, and animation stands), but they're not mutually exclusive; a single system can include more than one type of display.

ANALOG VS. DIGITAL

The usual method of distinguishing between analog and digital computers is by comparing the way they process signals internally: analog computers use a gradual scale, whereas digital computers use discrete on-off elements. But these characteristics are at a microscopic level and do not directly affect the user. A more useful distinction is at the level of user control. The way in which an instrument's control is structured will determine what will be easy to do and what will be hard.

For example, imagine trying to drive a car by typing commands on a keyboard, or trying to write by guiding a pencil with a steering wheel. Clearly, then, the control structure of a tool can determine its usefulness to a large degree.

If we compare the control structures of analog and digital computers we find . . .

Analog computers are controlled by routing signals through modules with cables, and by turning dials. Digital computers can be controlled in a number of ways, which may include turning dials or drawing with a pen, but primarily they're controlled by typing in commands at a terminal. A list of these commands is a computer program. A program is just a description of the steps required to complete a task. In the past when someone might have built a machine to perform a particular task, now he only describes the process in a program. A digital computer is a robot which will exhibit the behavior specified by the program and so become the machine desired by the user.

This is the most important feature of digital computers, and apprently the least understod by the computer illiterate. For example, when a TV journalist reports a story with the sentence, "Some students at MIT have developed a computer that can play chess," they invariably mean, not that they've built a computer but that they've developed a program. We use the word 'computer,' to mean a general purpose programmable machine. As soon as it's designed for a specific purpose, then it's no longer a computer. Also, once a program is stored in a digital computer, you can use it at any time in the future.

With analog systems, the way in which the modules are connected is the 'program,' and there's no way to store it. If you take it down so someone else can use the machine, you'll have to put it back together again next time you want to use it.

And there is another difference between analog and digital computers: in the analog systems, we saw that values, such as how far the beam is to be moved on the screen or how bright it is, were encoded in the amount of voltage in the wires. On digital computers, when using a vocabulary of command to control the display, these values are conveyed with numbers. Inside the computer, electronic signals are used to encode these commands and