Computer Pictures tours H-B's computer animation center

BEHIND THE SCREEN AT HANNA-BARBERA

by John Lewell

The team of Bill Hanna and Joe Barbera has brought us "Tom and Jerry," "The Flintstones," "Huckleberry Hound," and a host of Saturday morning cartoon shows and prime-time specials that are seen by audiences all over the world. Now Hanna-Barbera Productions has a fully operational computer graphics department that is helping to automate some of the stages of cartoon production, especially those later stages that are time-consuming when carried out by traditional methods. Our West Coast Editor visited the Hanna-Barbera studio in Hollywood to obtain the full story of this remarkably successful experiment.

Three VAX 11/780 computers configured as a VAXcluster (with 6 gigabytes of disk storage) form the heart of the Hanna-Barbera computer-assisted animation system.

Seen from the outside, Hanna-Barbera Productions looks much like any other major Hollywood studio. On entering, visitors must pass through security gates and leave the real world behind. But once inside this particular studio you are within the domain of Fred Flintstone, Huckleberry Hound and Yogi Bear—not to mention thousands of other famous cartoon characters. You will not of course catch glimpses of them strolling across the parking lot. In fact, the latest generation of Hanna-Barbera characters do not even exist on film. You will find them scattered throughout the buildings in the minds of the animators, on pencil sketches and, with the introduction of high technology to the animation process, in purely electronic media. Fred Flintstone no longer lives in a cave but inside a VAX computer.

THE PATH TO FAME

Bill Hanna and Joe Barbera were the creators of the original "Tom and Jerry" cartoons in the 1940s. These were made for M-G-M and were among the great classics of traditional animation: brilliantly funny and elaborately animated. Subsequently setting up on their own, Hanna and Barbera

were faced with some formidable problems, not least of which was the rapidly escalating cost of producing full character animation. It was a problem that was threatening the entire industry.

With considerable ingenuity, the two animators found a solution. They developed a completely different approach to their craft. By creating a simplified technique of stylized animation, they reduced the number of drawings that had to be made. The movements of the characters were restricted. Greater use of repetition was made. A new art-form emerged. The stories were as entertaining as ever, despite the economies in style, and very soon Hanna and Barbera became well-established in the new medium of television.

It was in 1976 that the animators were awarded their own star on the Walk of Fame outside 6753 Hollywood Boulevard. They had produced well over a hundred television series since 1957 and had won eight Emmys. This was a remarkable achievement, and one might have expected them to have rested on their laurels. But one of the secrets of their success had always been a willingness to experiment. They took an approach to animation that proved to be both flexible and capable of constant refinement. New ideas were accepted if they were helpful, and rejected if they were not.

It was in this context that, in the year following their entry to the Walk of Fame, Hanna and Barbera embarked on a new adventure. They discovered computer graphics, and began to appreciate the great potential of this medium for revolutionizing their industry.

THE PATH TO GRAPHICS

Christopher Odgers, currently Director of Computer Animation Systems at Hanna-Barbera Productions, described the evolution of the graphics installation at the studio. "In 1977, Donald Greenberg, who was—and still is—Director of Computer Graphics at Cornell University, together with Marc Levoy (then a graduate student) approached Hanna-Barbera Productions. The studio had already been wondering how production might be further automated. When we showed what we were doing at Cornell, Bill Hanna became very interested. He's been the motivating force behind this whole venture."

In particular, Hanna was excited by the prospect of computer-assisted cel-coloring, a process by which one can point to an area and immediately fill it with color. This had great potential at the studio. Shortly afterwards, Taft Broadcasting—Hanna-Barbera's parent company—and the studio itself entered into an agreement with Cornell University, supporting further research into the advanced techniques of computer-assisted cartooning. Chris Odgers, himself a Cornell graduate, noted: "We continued to pursue research in a number of areas. Not all of this research found its way into the production system. Some of the techniques were not cost-effective, others were not very practical. Then, in 1980, three graduate students including myself came with Don Greenberg to set up a pilot production system here in Hollywood."

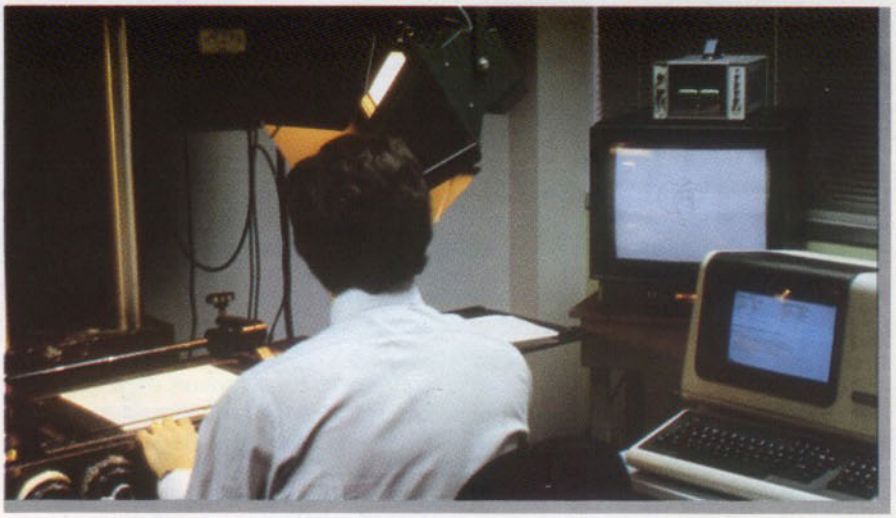
This initial system consisted of a VAX 780, three Grinnell frame buffers, and several pieces of video equipment. "We also continued software development," Odgers told us. "The initial Cornell software was really very 'prototype.' We rewrote it, and thus the complete pilot system became fully operational towards the end of 1982."

About a dozen episodes were produced on the system, each one being 22-minutes in length. As an experiment, the system was so obviously successful that it was worth expanding to cope with a larger throughput of work. Two more VAX 780s were added, together with more storage capacity, until about three times the original hardware was in place.

What precisely is the studio doing with all this equipment? Chris Odgers explained: "Our approach was to automate those parts of the animation process which tend to be repetitive. We do *not* try to sit artists down at computer terminals to practice their work! Animators here still do all the drawings. We don't even do key frame interpolation—although the system we developed at Cornell for doing this is just about as good as any that have attempted this aspect of cartoon animation."

Good though the Cornell system was, key frame interpolation is not easily automated. The Hanna-Barbera studio considers the computer-assisted technique to be currently unsuitable for professional character animation. One problem is that cartoon characters do not transform from one position to another with all parts moving at a constant rate. They perform non-linear motions, and have different parts moving at different speeds. A second problem is that a cartoon is really a 2-D description of a 3-D object. Computers still have difficulty in making hidden lines disappear correctly during interpolation from one frame to another.

"These are all artificial intelligence problems," commented Odgers, "and they have not yet been solved.



All artwork for the computer system is digitized at a scanning station connected to Grinnell image processing frame buffers. Artwork consists of animators' pencil drawings as well as full color backgrounds.

is television it does work well for us—and, yes, it could be further expanded."

What were the chief considerations in deciding to use videotape rather than film output? "When we implemented the system, videotape won because of several reasons. There is neither film processing time nor the costs involved. Videotape is a much less expensive medium. Another factor is that we have much better control over color quality. By going directly to videotape we eliminate film-to-tape transfer. The color is therefore all-electronic and can be controlled very precisely. Film emulsions are much more complex to deal with. But with videotape there are no scratches, no film dirt—and perhaps the biggest advantage is that there is no time lost in waiting to see what retakes (if any) are necessary. We get a very quick turnaround."

Is it possible to quantify the savings in time over conventional methods of assembly and exposure? "The actual numbers are proprietary. All you really have to do is to watch someone coloring cels conventionally and you can imagine how long the older method would take. I'd say the time-saving in cel-coloring is well over 5 to 1. All camerawork is done solely by the machine. And in the digitizing, which is analogous to the xerography stage, savings can exceed 5 to 1. Of course, you have to bear in mind that we've automated only a small part of the total process that goes towards making an animated film. We're concerned only with the last stages. A large proportion of the costs are incurred at the beginning—in the creative stages. But we still make a significant contribution."

VITAL STATISTICS

Touring the Hanna-Barbera computer systems department we noted just how immense the installation really is. Each of twelve Digital Equipment drives can hold up to 476 Megabytes of data. The entire system has nearly six **billion** bytes of memory. This enormous capacity is necessary, since each 22-minute show requires approximately 15,000 drawings. Between three and six shows can be stored in the system simultaneously.

Signals from video cameras in the scanning department enter the computer room where they are processed by the bank of nine Grinnell image processing frame buffers. The Grinnell machines clean up the images, which are then passed through the VAX computers onto disk. The computers themselves are run as a "cluster," with all three machines running off a central group of mass storage devices. By this means, all the computers have access to all the storage.

In a separate room, coloring artists work at their stations, calling up images from disk and inserting the appropriate colors from specially selected palettes. The paint program at Hanna-Barbera is customized for the studio, designed specifically for cartoon cel-coloring and drawing touch-up. It is not a general-purpose painting system. However, it appeared to be very fast in operation, with images being called up and filled with color all in a matter of seconds.

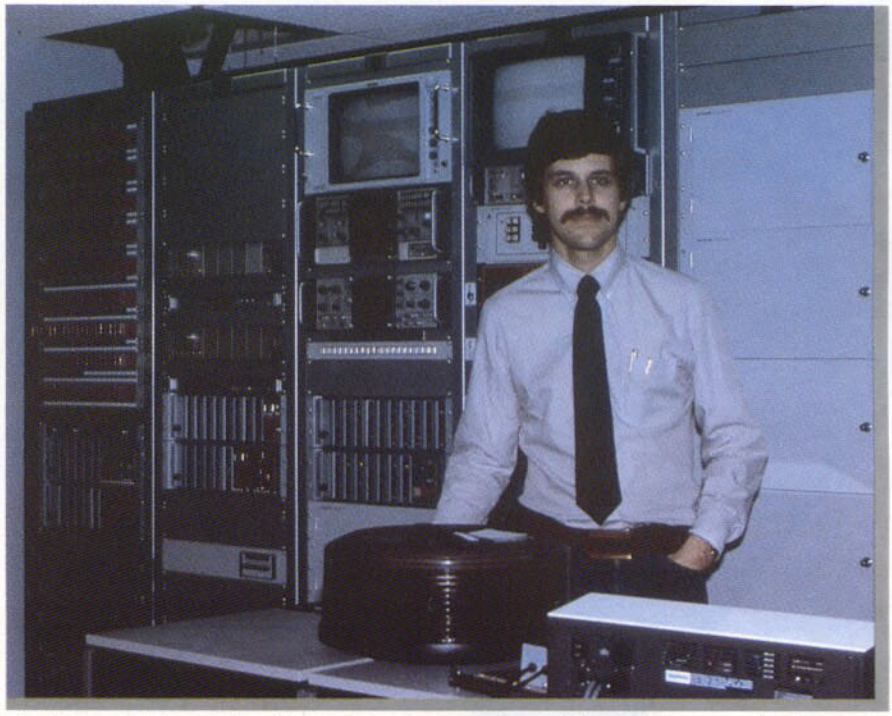
The entire investment in computer graphics at Hanna-Barbera is clearly in the region of several million dollars.

NEW HORIZONS

Having tackled the major areas of xerography, cel-coloring, and camerawork—and having done it successfully—Hanna-Barbera is looking at new applications for computer graphics in cartoon animation. Said Chris Odgers: "We may soon be painting backgrounds with the system, not for the cost savings but really so that we can obtain some new effects. By having an electronic paint system we could achieve effects that would be very difficult to create conventionally. That's probably the next technique on the agenda."

It is not, however, the only one that looks promising. In the 1930s and 1940s, Walt Disney Productions was using what was called a "multiplane camera." This was a very complex machine with multiple layers of glass that could be several inches or even several feet apart. The camera gave an effect of true three-dimensionality as it tracked into the image, the background having real depth as a result of the multiple planes. Its disadvantage was its complexity, and the fact that it took about ten people to operate it.

At Hanna-Barbera they plan to use the computer to create genuine multiplane effects, very similar to those that were once achieved at the Disney studio. Said Odgers: "In our system we can actually perform a zoom within the computer, and enlarge different layers of a frame at different rates.



The Hanna-Barbera animation system includes sophisticated video monitoring and control equipment.

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Those parts of a background that are partially transparent, or which have cut-outs, are called 'overlays'—and we create a number of overlay sections through which you can see to the layer behind. This capability allows us to produce true multiplane effects."

Since the Hanna-Barbera system was installed, several improvements in hardware have been made. Yet Chris Odgers still feels that finding appropriate hardware can be the biggest problem in setting up a similar installation today. He commented: "The major obstacle that you have to overcome when you create a computer graphics system for direct interface to broadcast television is the fact that the computer graphics industry rarely talks to the video industry, and vice versa. Although this situation has slightly improved in the last two or three years, we had great difficulty in finding hardware that would produce an acceptable broadcast signal. A second problem was in finding equipment that would record while doing frame-by-frame assembly. We used the Ampex ESS2—and this was the only satisfactory device at the time. Now, other tape machines from both Sony and Ampex are capable of frame-by-frame assembly, but we've not tested them yet."

Another promising development, noted by Odgers, is the Pixar 2-D from Lucasfilm. It is possible that this frame buffer will help to bridge the gap between computer graphics and video. Other devices, from Japanese companies, are helping animators to automate pencil testing. These machines are one-bit frame buffers that can store several hundred images and play them back with alternative timings. While Hanna-Barbera is not yet using these systems, it is clear that every means of practical automation is being considered.

AUTOMATION & THE ARTIST

Ultimately the success or failure of an animated picture is dictated largely by the skill of the artists who create it. This is one aspect that has not changed at Hanna-Barbera. At first, artists were wary of the new computer installation. There were fears that it would take over creative functions, and perhaps even make some artists redundant. Happily, this has not happened. While the system was intended specifically to automate the later aspects of production, artists themselves have found it useful in enhancing their creativity.

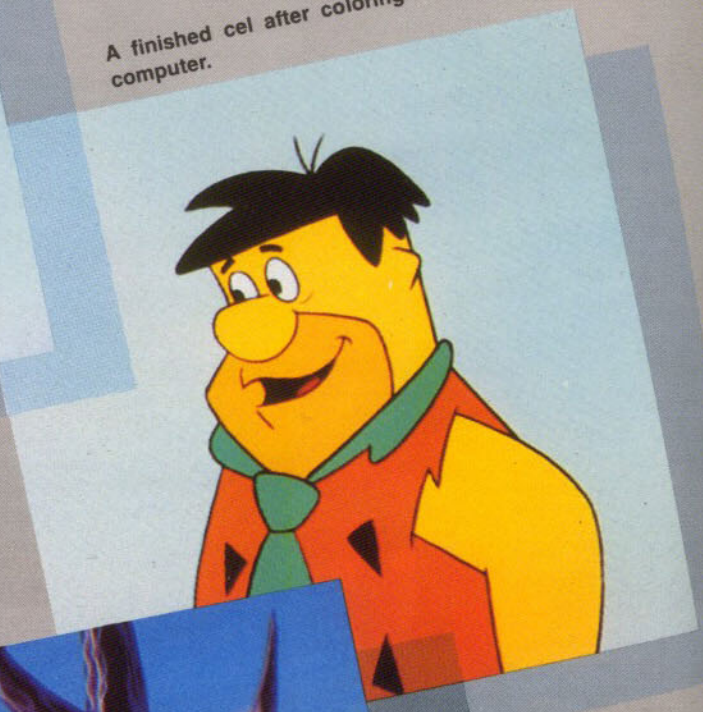
One example of this phenomenon has been in the use of more than the traditional number of five cel layers during assembly. In the conventional process, acetate cels tend to degrade the color of their images, setting a maximum of five cel layers in the "cel-sandwich" that is placed beneath the camera during exposure. But with computerized assembly, a virtually unlimited number of layers can be used, with no degradation whatsoever. The bottom layer is as crisp and bright as the top one. Now, with many more layers at their disposal, artists have increased freedom to split the frame up into many different parts. Excess drawing is eliminated, and the artist can concentrate entirely on those parts that are intended to move. There is little doubt, too, that artists enjoy the superb consistency of color that the system imparts to their work.

Gradual introduction of computer graphics to the animation process has been markedly successful at Hanna-Barbera. Even by industrial standards it is a significant installation, and perhaps one of the very largest in the applied arts. However, full computerization (if it ever comes) will require some unique solutions in the field of artificial intelligence.

Come on, you guys at Stanford and MIT, Fred Flintstone is waiting to hear from you!

A digitized animator's pencil drawing.

A finished cel after coloring on the computer.



The cel merged with a digitized background to produce a finished frame of animation.