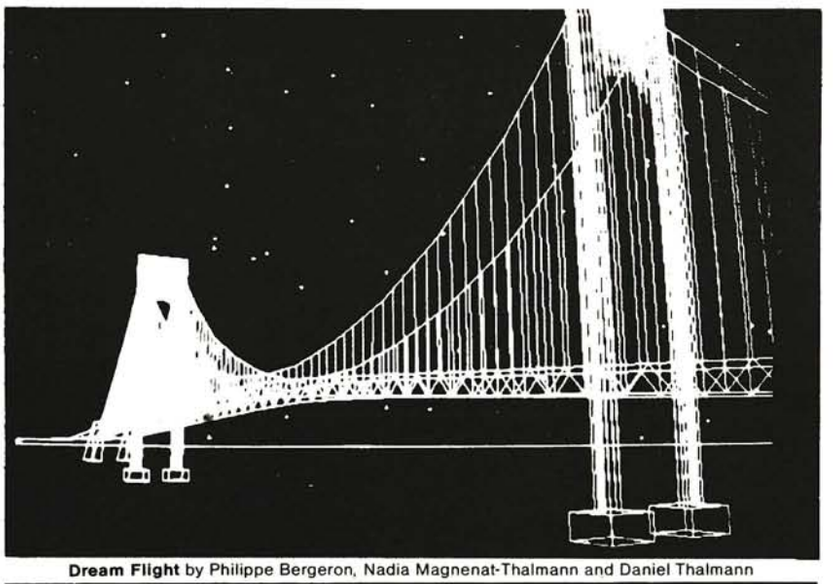
Of bits and bytes



Dream Flight by Philippe Bergeron, Nadia Magnenat-Thalmann and Daniel Thalmann

by Arthur Makosinski

"No jaggies" was the underlying motto of Siggraph 82, the Ninth Annual Conference on Computer Graphics and Interactive Techniques, held this year in Boston. The term "jaggies" refers to the serrated, block-like patterns produced on image edges of some computer generated images.

Computer-assisted animation is already the norm at some of the larger animation houses like Hanna-Barbera in California. The animator is not replaced, but rather he is given a new, powerful tool. He still draws individual cells by hand, but his "canvas" is a digitizing tablet connected to a large piece of a computer memory, which is displayed for the artist on a color video monitor.

His "Brush" is an electronic stylus resembling a pencil. Its effective shape can be any shape he desires, as long as it fits into the allocated computer memory.

On the bottom of the monitor screen is a "palette" of 256 colors in which he "dips" the stylus. In this way, the animator "paints" the outline of his figures and can also automatically fill and clear large areas, save and restore pictures, magnify the "canvas" selectively for detail work, and record histories of picture composition. He can also combine several pictures together, or call up previously recorded pictures of, for example, trees and seed them all over his current "cell." Similar treatment is used for producing background cells and titles.

The memories which store the huge amounts of digital bits associated with each scene are called "frame buffers." A single animation film frame may require as much as 500 kilo bytes (eight 'bits' equal one 'byte') of memory for a modes screen resolution of 512 x 512 lines and 8 bits assigned for each color: red, blue and green. In a half-hour show, this translates to over 500 million bytes of memory. The directly accessible memory space is the bottleneck of digital image creation. Such memory size, although possible, is still expensive and bulky.

Somewhere during the completion of a computer-animated film, a decision is made whether to "dump" the images on film or onto video tape. In case of a studio like Hanna-Barbera, whose products are for T.V., the image goes from the digitizing tablet to frame buffers, to hard magnetic disks and finally to one-inch C-type videotape. If the image is destined for the big screen, it is usually transferred directly from frame buffers, or sometimes from hard disks to a high-resolution monitor with a 35mm camera in front of it, or in some cases directly to film using a modulated laser beam. Traditional animation techniques are also often combined with computer-painted images and the two are transferred either to video or 35mm film under computer synchronization. In general, most sophisticated programs for computer animation systems are made to measure and are not available commercially. Ampex took three years to build the system for Hanna-Barbera, which also had to buy the people who came with it.

Other studios, like the one at The New York Institute of Technology, have also developed their own software, but are willing to sell at least some of it. "Tween" is a key-frame animation system program where the artist draws or enters key-frames and the computer interpolates the missing ones. Written by Ed Catmul, its operation is similar to the programs which created Peter Foldes' *Meta Data* and *Hunger*, the National Film Board of Canada's early contribution to this field. What distinguishes Catmul's program, beyond its use of color, is that Foldes used direct, vector images, while Catmul's program is adopted for the more difficult, vast scan systems. That is where "the jaggies" have to be dealt with through complicated dynamic anti-aliasing algorithms.

It was most refreshing to view *Meta Data* along with other oldies but goodies, shown at the Siggraph. The film still stands out head and shoulders above other similar efforts.

The new Canadian offering at the Siggraph was *Dream Flight* made by Philippe Bergeron and the Thalmanns. Shot off a Tektronix 4027 vector graphics terminal connected to a Cyberg computer, it was similar in technique to the Peter Foldes films and, although it spirited clever animation, it seemed dark and pretentious in its theme and choice of music.

The great treats of the show for many were the examples of solid, three-dimensional computer-generated imagery. Already used for creating TV logos and commercials for Life Savers and The Bell System, and the PBS 'Nova' and NBC logos, these directly generated synthethic images are the result of a marriage of graphic artists and some of the brightest minds in mathematics and computer science. This year also marks the first time that these images were used in two feature films, notably *Star Trek II* and *Tron*.

Lucas Films, a division of ILM Company, was responsible for creating the 1261-frame scene in which the space ship flies by a dead plane, throws a genesis bomb, and brings it to life. Here are some details on how this remarkable image was shot as described by Alvy Ray Smith of Lucas Films.

(1) Exact star positions were deter-

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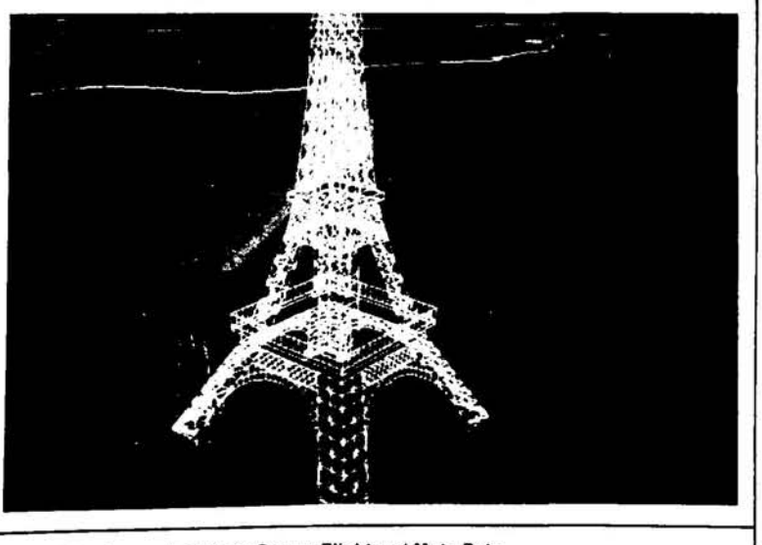
● Foldes' **Hunger** was a pioneering effort

● Scenes of tranquility in **Meta Data** and **Dream Flight**



● Reaching for new heights in **Dream Flight** and **Meta Data**

mined from the "Yale Bright Star Catalog," generated and fed into magnetic disks.

(2) The projectile path of the space ship with respect to the earth was calculated as a 6th degree polynomial and modelled on a vector display.

(3) The image of the planet was painted by C. Evans of ILM, digitized and "wrapped" mathematically on a sphere with shade by T. Duff.

(4) The explosion-strip image was generated by tracking 400,000 particles in several planes, all anti-aliased (no jaggies) and motion-blurred.

(5) The atmosphere was [illegible]ted from actual physics formulaes [illegible] Baxter's "Physics."

(6) The most difficult images of the surface of the planet, the mountains and the sea, were the results of what mathematicians know as hidden-surface algorithms consisting of 231 data points, mathematically "wrapped" on a sphere, with separate algorithms for color and shade. The calculations generated the so-called "fractal" (irregular topological dimensions) mountains whose positions and dimensions were recalculated for each frame.

(7) The scenes were then synchronized, and the output of the DEC, VAX computer was connected to a standard Barco, 500 x 486-line RGB monitor. A Vista-Vision camera loaded with 5247 films was placed in front of it. The whole filming process was automatic, and no one was present during the most of the nine hours it took to shoot the 1261 frames.

The film was delivered on time and in the exact format the producer wanted.

Tron made much more elaborate use of computer-generated animation. In fact, over 64% of the film was computer generated. Most of the computer work was handled by Information International Inc. and Magi-SynthaVision. All geometric models were based on sketches provided by Disney animators. Some figures, like the Sark's Carrier and the Solar Sailer, were created by digitizing orthogonal views of the Disney drawings, then test-viewing them on a vector display before the final encoding.

Other more regular shapes and shading were created using a wide variety of existing and specially written programs by III. Shot with a resolution of 1024 x 1024 lines with six bits depth of each primary color, the resulting resolution is as good or better than that shot with a lens of 35mm film. Relatively few people were involved on the computer end of the production, and no paper or wire models were used.

At one of the Siggraph presentations, Ed Catmul tried to set a goal for the future of computer graphics in film. He targeted realism and its manipulation as the chief aim, underlining that no words can compensate for a bad picture (don't we know that, Ed!). "Don't show a picture you have to apologize for, continue progress for higher quality," he touted. "Don't think of any hidden-surface algorithm, without thinking about the anti-aliasing (the jaggies problem)."

Computer resources for the purpose of making pictures are scarce. Researchers and experts in this field tend to associate with academic institutions or the U.S. Defence Department. Little work of this kind is going on in Canada, right? Not for long. Sheridan College in Oakville has just announced Canada's first one-year certificate program in Computer Graphics. Anyone interested?