ABOUT THE COVER

Nature at New York Tech

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Figure 1. *Turbulent Flames* by Kevin Hunter. This image began as a statistically pure randomness and was filtered by the 1/f frequency response characteristic of many highly chaotic natural events, such as the movement of a particle suspended in fluid.

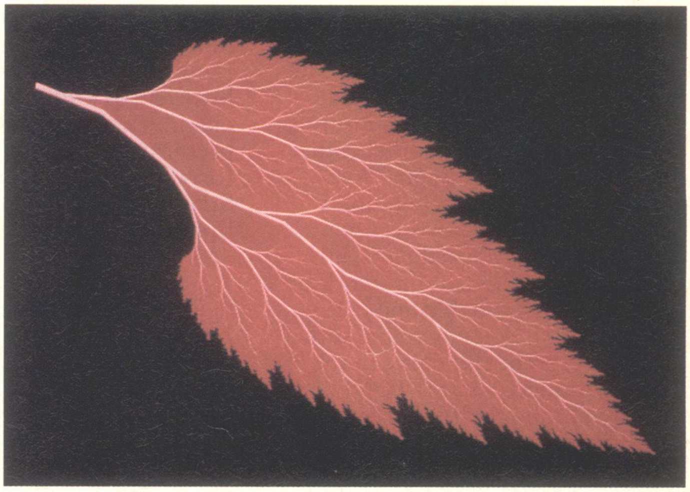

Figure 2. *Fall Leaf* by Peter Oppenheimer. The recursive application of rules results in a repeating, scale-diminishing pattern.

Since 1974 the New York Institute of Technology has been a home to artistic expression as well as scientific development. The myriad images created over the years reflect the wide-ranging interests of the lab's researchers and animators. Although gleaming globes and robot romances have long been popular at New York Tech, considerable activity has also been devoted to representing natural phenomena.

Why should representations of nature be of interest? Certainly they are metrics in assessing the capabilities of a graphics system, because natural forms are usually much more complex than artificial ones. And often such representations enhance the realism of a synthetic scene, which is important for many applications.

But of course computer graphics, with its ability to define and manipulate three-dimensional forms, is a powerful tool for the imagination. It seems only natural that traditionally inspiring elements of nature attract the attention of computer graphics designers and artists.

Nature and Structure

The cover picture represents a maple tree as a combination of two active computer graphics ingredients: well-defined geometry and random variation. Nature is interesting because it constantly applies the one to the other.

For example, a forest is an apparently random collection of individual trees, but each tree has a genetically determined structure. And yet within that structure exist such variations as the number of branches, the shape of the canopy, and so on. But again, within these variations is found the fixed geometry of the individual branch. And upon the branch are found new variations like bark or moss.

Each application of variation to geometry may be considered a level of detail. Computer techniques can emulate these levels quite well; commonly, predefined variations are

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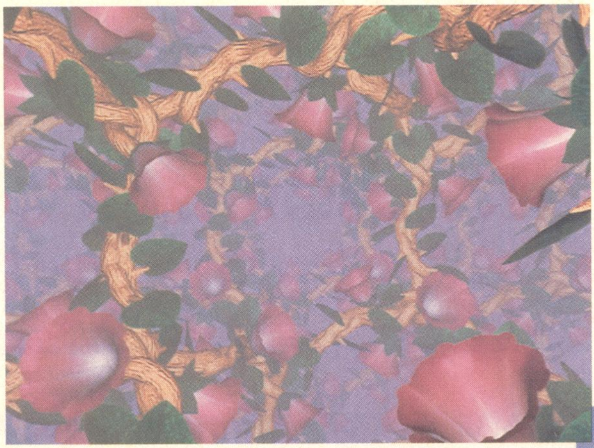

Figure 3. *Inside A Quark*, by Ned Greene. Repeating elements in infinite regression produce a model created for the Omnimax film *The Magic Egg*.

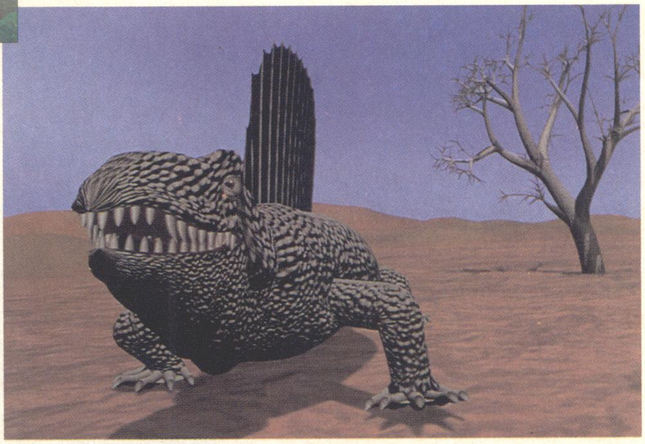

Figure 4. *Dimetrodon*, by Dick Lundin. This is a still from a "critter animation," demonstrating flexible geometric techniques.

mapped as textures onto a mathematically defined geometry. Modern graphics systems should allow artists and designers to use these techniques flexibly.

Geometric complexity

Often, the more an artist designs an image, the more structured are its geometric forms and the more specific are its textures. At a given level of detail, the geometric forms determine the recognizable content of an image, and subtleties such as texture determine the realism of the image.

Images produced with Kevin Hunter's texture-design tool have sophisticated mathematical foundations but are without geometric structure. Thus, in Figure 1, aside from the notion of flames, there is little from the natural world that one can recognize.

If the texture of Figure 1 can be said to have characteristic *statistics*, then the recursive patterns shown in Figure 2 may be said to have characteristic *rules*. Here, variation was used not to modulate the intensity of the image, but to influence the direction of the leaf veins. Since the image manifests more geometry, the object is easier to identify.

The vine shown in Figure 3 is highly structured, tracing the edges of a diamond lattice. The resulting repetitions in the image exhibit an almost hypnotic complexity.

At the far end of geometric complexity is Dick Lundin's *Dimetrodon*. Here an entire "natural" world is created, and there is much the viewer can recognize.

Nature and Technology

Modeling natural phenomena with a computer is a contrast of activities. On the one hand, it requires a close study of the natural form; "such a study," writes Heinrich Hertel, "will be rewarded with a totally new perspective—the living world revealed as if for the first time."[1]

On the other hand, many hours before a computer workstation are required. Despite the occasionally changing display, this is a static activity, one which is, according to Buckminster Fuller, "frustrating man's instinctive drive to comprehend his direct experiences."[2]

These remarks suggest that a balance is needed between our involvement with technology and our existence within nature. But as the world urbanizes, this balance becomes harder to achieve. Our priorities become more urban. We increasingly cherish our cars and their parking spaces more than the forests.

Yet technology can embrace as well as displace nature. If trees can be modeled, for example, so might buildings that sit well next to them. Eventually we may rely less on our own contrivances and more on a harmony with the natural world.

References

1. Heinrich Hertel, "Preface," *Structure, Form, Movement*, Van Nostrand Reinhold, New York, 1963.
2. Buckminster Fuller, *Synergetics*, The MacMillan Company, New York, 1975, p.27.

Jules Bloomenthal was a research scientist at the New York Institute of Technology when he created the image of the tree. He is currently at Xerox PARC. He received a BA from Rutgers College and an MS from the University of Utah.