Images of Hyperspace

Banchoff, computer-drawn graphic: Shades of Captain Marvel

Considering that no one can pinpoint what or where it is, the fourth dimension has proved remarkably inspiring over the years. The concept of a direction beyond height, width and depth has intrigued writers and artists from H. G. Wells to Salvador Dali and has captured the imagination of Hollywood. When Han Solo wanted to escape the evil forces of Darth Vader's Empire, for instance, he simply blasted his starship into hyperspace.

Mathematicians as well as scifi fans have long been drawn to 4-D, or hyperspace. But laymen—and some scientists—have been slow to accept something they could not visualize. Now, however, advances in computer graphics are permitting theoreticians to illustrate this abstract concept, and 4-D is finally coming down to earth. The first world conference on the fourth dimension was held recently at Brown University, attracting some 700 enthusiasts from the worlds of art and science. According to art historian Linda Henderson, who has chronicled the influence that 4-D shapes have had on painters from Duchamp to Mondrian, "This idea has caught the attention of people from all walks of life."

In the past, many scientists have followed Einstein and designated time as the fourth unit of measurement. But the recent view of many cosmologists—that the universe is finite but unbounded and curving back on itself—has led today's hyperspace enthusiasts to speculate on a fourth *spatial* dimension. The curvature, they believe, is that extra dimension. To detect it, one could (in theory) shine a laser into the void and wait a few billion years: the beam of light would traverse the universe, like an ant crawling over a beach ball, and eventually wind up shining on the experimenter's back.
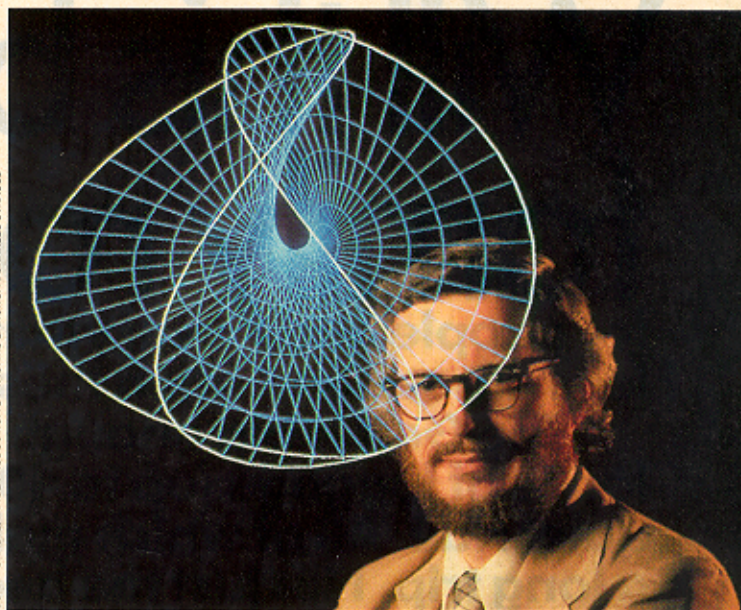
The fourth dimension's chief apostle is probably Thomas Banchoff, the mathematician who organized the Brown conference and who has created some of the most spellbinding computer images. Banchoff, who says his passion for 4-D was piqued by an early devotion to Captain Marvel comics, has made several stunning films about his theories. "The Hypercube" gives viewers a tour of this basic 4-D object. In contrast to the eight vertexes and six squares that make up a three-dimensional cube, the hypercu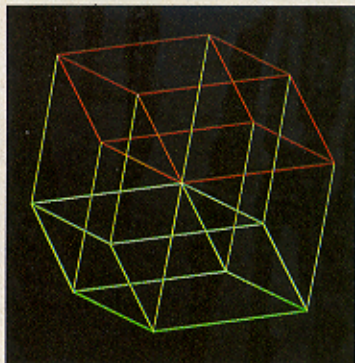be has 16 vertexes and eight cube faces. In "Flows on the Torus," Banchoff depicts the relationship between two pendulums swinging at different rates by showing brightly colored, doughnut-shaped figures called tori. The curves represent the changing positions and velocities of each pendulum. "What we do, essentially, is take a 3-D snapshot of a 4-D object," he says, "then walk around it and accumulate enough views to begin to understand it"—much as one might imagine a rotating 3-D object by studying its 2-D shadow.

Hypercube: A snapshot of 4-D

Banchoff's work was encouraged by "Flatland," the 1884 satire on intolerance written by clergyman Edwin Abbott Abbott. In that classic, 2-D creatures deny the possibility of a third dimension even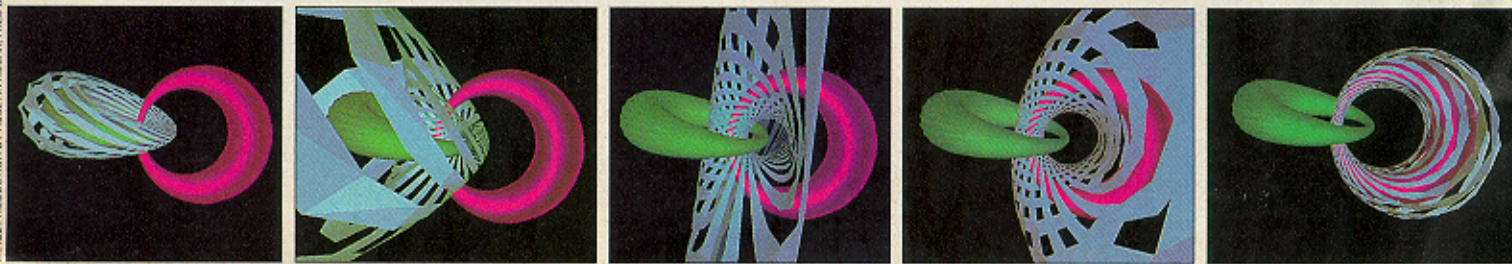 after they're visited by a 3-D sphere. The Flatlanders can't comprehend the new measure because they live on a plane—and Banchoff likes to compare their experience to the way earthlings might witness 4-D. When the Flatlanders—imagine amoebalike shapes on a pond—are confronted by a sphere descending from above, they see only the part that intersects the pond's surface. Their first view is of a point, followed by circles of increasing diameter—up to the largest at the sphere's equator—then diminishing circles and, finally, a point that vanishes. By analogy, a 3-D human visited by a hypersphere would see a tiny sphere, then larger ones, until they began shrinking and disappeared.

Signals: Though the theories may still sound farfetched, scientists are finding practical applications for 4-D. Statisticians are using it to plot complex equations that have four variables. The Office of Naval Research, for one, expects 4-D graphs to uncover the relationship between the temperature, salinity, biomass and strength of currents at particular points in the ocean, so that the Navy can track acoustic signals traveling through water. Geologist Thompson Webb of Brown is using the graphics to draw conclusions about past climates. By correlating longitude and latitude with the amount of pollen found in bore holes in the soil and the depth of those holes, he hopes to chart the ancient boundaries of pollen-bearing plants and thus of temperate zones. The use of hyperspace graphics to chart the world may be only beginning. Already, physicists are exploring the idea that the universe actually contains *11* dimensions. If they are correct, then the Flatlanders didn't know the half of it; even the fourth dimension may be just the shadow of reality.

SHARON BEGLEY with SUSAN KATZ
in Providence, R.I.

Frames from the film 'Flows on the Torus': After Hollywood and H. G. Wells, a science-fiction concept comes down to earth