sity in Ithaca, N.Y. Nixon and his colleagues are using transplanted chondrocytes to mend joint fractures and torn cartilage. Since the beginning of the year, they've treated about a dozen horses. The surgery "will definitely be used in people," though not for many years, Nixon contends.

They describe their findings from earlier experiments, in which they used this technique on eight horses, in the October JOURNAL OF ORTHOPAEDIC RESEARCH.

The procedure helps only animals with recent, serious bone fractures and cartilage damage in their joints. It's not for horses that have had arthritis for more than about 6 months, Nixon says.

He and his colleagues take cartilage cells from dead horses, freeze the cells, and then grow them on an as-needed basis. They hope to develop a way to use the injured horse's own cells, thus avoiding any immune response to the foreign cells. As far as Nixon knows, however, no such reaction has occurred yet.

The horses get two mixtures at the same time. One includes chondrocytes and a protein called fibrinogen, which helps glue the cells in place and prevents them from taking on the shape of scar tissue cells. The other contains growth factors and thrombin, which activates the fibrinogen. The investigators use a thin surgical tool called an arthroscope to inject the substances. In 6 to 8 months, the animals appear to function normally, and the racehorses can return to the track, he says.

Nixon believes that this approach has numerous advantages over the Swedish method. For one, it requires less invasive surgery. Also, because his group uses growth factors, fibrinogen, and more cartilage cells, "I suspect we'll have a better outcome," he asserts. □

Battling bad knees

The den in 72-year-old Suzanne Dettmer's house looks like a coach's office. It's the shelves. They are loaded with trophies. She and her husband won them running races, a sport she took up about 20 years ago. But in recent years, doctors who examined one of her knees grimaced. Among other problems, most of the knee's cartilage was gone.

Dettmer, my aunt, thinks an injury she suffered as a young woman never healed properly. If she had received a cartilage cell transplant at that time, she might have avoided developing osteoarthritis, according to her physician, Thomas P. Sculco, an orthopedic surgeon at the Hospital for Special Surgery in New York City. It's too late for the technique now, however.

Eventually, like many other people with her condition, Dettmer had to have a surgeon outfit her with an artificial knee, one of the few available treatments for cartilage problems in that joint. Physicians have no way of actually repairing the damaged tissue, which heals poorly on its own, they acknowledge. And generally only people over age 60 get a knee prosthesis, since the device wears out in about 15 years and must be replaced.


Robert Dettmer

For now, Dettmer is happy with her new knee, which she got in January 1993. It's holding up well, despite a rather tough trial run: In October, she competed in her first triathlon since getting the device. And she completed the event — a half-mile swim, a 14-mile bike ride, and a 3.1-mile run — in 2 hours and 24 minutes.

In terms of age, she outranked her competitors by 12 or 13 years. Still, she didn't come in last, she cheerfully points out. — *T. Adler*

Computers

Ivars Peterson reports from Fairfax, Va., at Visualization '94

Illuminating the fourth dimension

A photograph in a magazine or an image on a computer screen is inherently two-dimensional. Nonetheless, such representations often contain visual cues that help create an illusion of three dimensions. For example, by taking into account the size, relative placement, and shading of familiar objects in a scene, one can get a remarkably complete three-dimensional picture of a two-dimensional view.

Analogous visual cues may also enable viewers to "see" four-dimensional objects in three-dimensional settings, says computer scientist Andrew J. Hanson of Indiana University at Bloomington. Hanson and graduate student Robert A. Cross have developed a scheme for viewing a knotted sphere — the four-dimensional analog of a knotted string. In this case, the fourth dimension is simply an additional spatial coordinate.

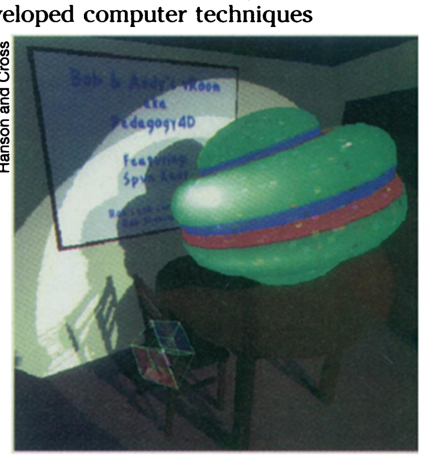
Suppose one were creating a two-dimensional picture of a knot in a string. As a mathematical object, the knotted string would be invisible because it has no thickness. In drawing a mathematical knot, one is forced to thicken the line to make it visible. Moreover, because the knot itself is a three-dimensional object, one must use shading or breaks in the drawn line to show which parts cross over or under each other.

Visualization experts face similar problems in creating an image of a knotted sphere. The four-dimensional object's infinitely thin, three-dimensional shell must be thickened and crossings suggested by suitable markings. It's also possible to go a step further by making the shell shiny. Illuminated by a single light source and seen from different angles, various points on the shell reflect light in particular directions.

"The direction of the light tells us an amazing amount — much more than a [knot] crossing diagram," Hanson says. "It gives us additional information about where the object is facing in the fourth dimension."

After developing techniques that allow the generation of such three-dimensional images in fractions of a second, Hanson and his coworkers displayed their knotted sphere in the Cave Automatic Virtual Environment (CAVE) at the National Center for Supercomputing Applications, located at the University of Illinois at Urbana-Champaign. Here, the viewer can don stereo glasses to interact with three-dimensional graphical images projected into the CAVE room.

But the knotted sphere visualization didn't work very well in the CAVE. "It's hard to see the thing unless you have some additional human context — like shadows and familiar objects," Hanson says. Cross has now developed computer techniques for rapidly creating graphic representations of rich, three-dimensional environments to serve as nonthreatening settings for exploring the strange, unfamiliar realm of four-dimensional objects.


Hanson and Cross

Computer visualization of a four-dimensional knotted sphere floating in a three-dimensional setting. The glint on the object's surface appears inconsistent with the shadows and provides a hint of its four-dimensional character.