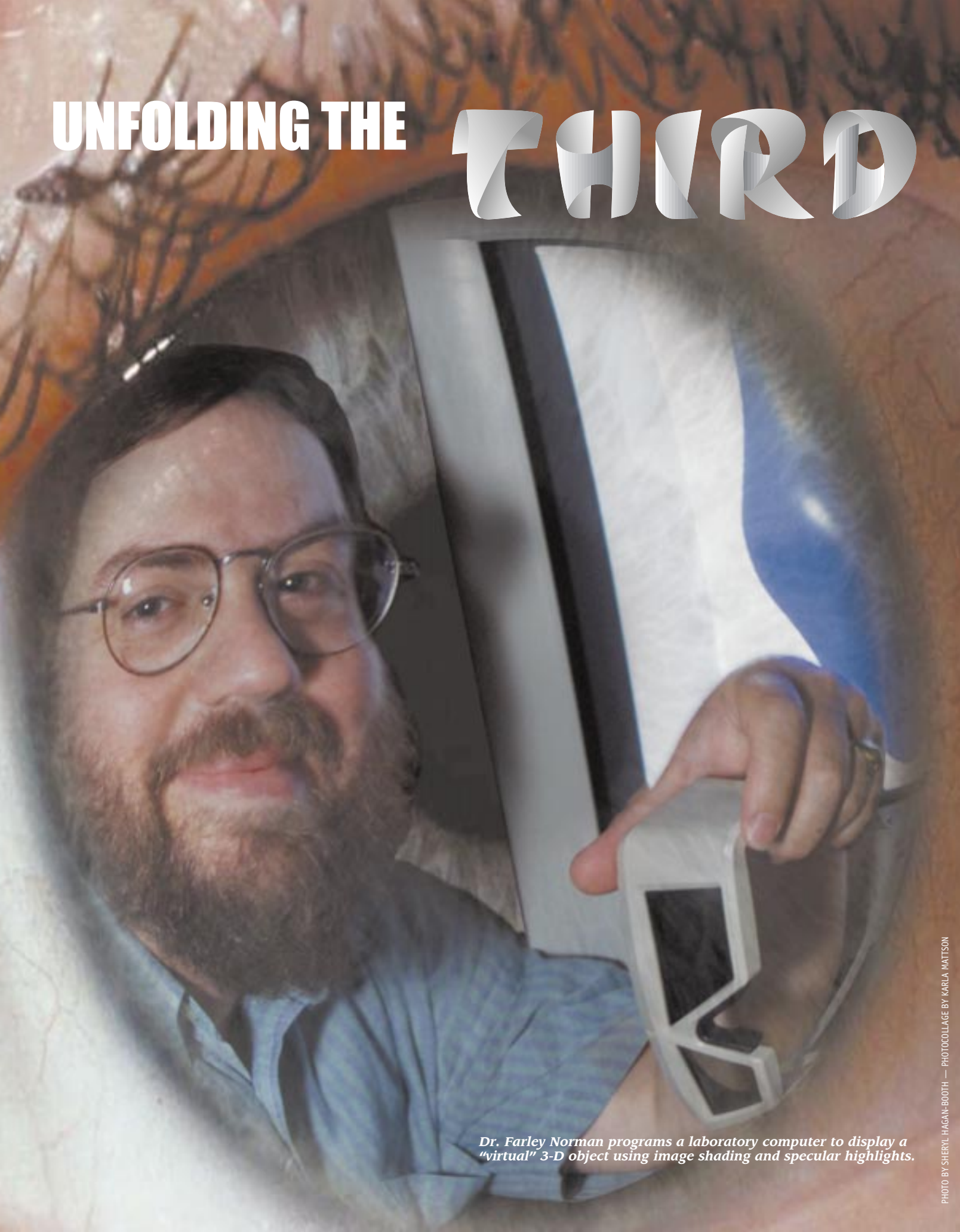


UNFOLDING THE

THIRD



Dr. Farley Norman programs a laboratory computer to display a "virtual" 3-D object using image shading and specular highlights.

DIMENSION

BY MELISSA SELVAGE

IN THE 1960s, THE PUBLIC WAS MESMERIZED BY 3-D MOVIES. SPORTING CARDBOARD GLASSES WITH RED AND BLUE LENSES, MOVIE PATRONS DODGED THE IMAGES AS THEY APPEARED TO JUMP OFF THE SCREEN. BUT FOR THE 5 TO 10 PERCENT OF THE POPULATION THAT DO NOT POSSESS STEREOSCOPIC VISION, THE EFFECT WAS UNNOTICEABLE.

J. Farley Norman, an associate professor at Western Kentucky University with a Ph.D. in experimental psychology from Vanderbilt University, has spent more than 15 years figuring out how the human mind perceives the shape of three-dimensional objects.

In addition to his own research, he has a web of colleagues at other universities, including psychologists, physicists, and physiologists at Vanderbilt and Ohio State Universities in the United States, and a number of universities in Belgium and the Netherlands. Norman travels about once a year to Belgium, where he participates in the research of scholars who study the areas of the brain that are involved in the perception of object shape. "I think we make a pretty good team if we each apply our own areas of expertise," Norman said.

Norman spends many hours in the "Gustav Fechner" laboratory (named after Gustav Fechner, a physicist who applied experimental methods to the study of human perception in the 1850s), working alongside graduate and undergraduate students studying how humans perceive three-dimensional objects, while his collaborators in Belgium focus more on the physiological aspects of perception in the brain using such tools as fMRI (functional magnetic resonance imaging).

Norman said that while the perception of objects is something that we don't think about very often, it actually accounts for a large part of what the brain is doing all day, everyday. "About half or more of the cerebral cortex of our brain is devoted to vision, in one way or another. It's actu-

ally a remarkable accomplishment of the brain that we see and perceive the shape of environmental objects as well as we do," Norman remarked.

Although it may seem simple, the process of 3-D shape perception is actually quite complicated. Somehow, the neural mechanisms within the eye and brain derive useful information about the three-dimensional shape of objects from the two-dimensional optical patterns of light that enter our eyes. In particular, the variations of shading and patterns of motion within the optical images at the back of the eyes contribute to the perception of 3-D shape. In addition, most human observers can perceive the 3-D shape of objects more accurately if they view the objects with both eyes simultaneously via a process known as stereopsis, which literally means "solid vision". In his research, Norman studies how we perceive 3-D shape from stereopsis, motion, and patterns of optical shading.

According to Norman, the study of perception is fundamental to the field of Psychology. Psychology refers to the

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scientific study of the human mind and behavior. "Practically everything we do depends upon the perception of object shape. For example, we cannot even pick up our coffee cup or glass of orange juice in the morning unless we first perceive its shape and location relative to us in three-dimensional space. Certainly, one could not successfully drive a car if one were unable to perceive the 3-D shape and position of surrounding cars, trees, people, and other obstacles."

Although his research on perception has spanned many years, his career goals were not always clear. At the University of Texas at Austin, where Norman received his bachelor's degree, he spent most of his time as an electrical engineering and math major. "I thought I was going to be an engineer," Norman said. "Then I took a class in psychology (cognition) as an elective. I was surprised to learn

that Psychologists scientifically study how humans think, solve problems, and store information in memory in such detail."

When it came down to the last semester of his senior year, he had a tough choice between earning a degree in math, engineering, astronomy, or psychology. "I happened to take a second class in Psychology (in perception) and I was hooked," he said.

After finishing his post-doctorate in experimental psychology at Brandeis University and Ohio State University, Norman applied, along with about 200 other professionals, for the few tenure-track professor jobs available each year in perception. "I just kept on applying and made it," he said.

Over the past five years at Western, Norman has continued his pioneering research while teaching various courses, such as history of psychology, sensation and perception, statistics, and introductory psychology. But what does his research mean to the rest of the world? "The possibilities are endless," Norman said. "If we can understand how people do it (perceive 3-D object shape), then we could possibly get machines to do that."

Norman compares the future to "something out of the Jetsons." Some of the possibilities include:

- cars that could "see" surrounding vehicles and obstacles, thus preventing accidents and saving lives;
- improvements in manufacturing efficiency with industrial robots that could be more autonomous than current ones due to their ability to perceive 3-D shape and manipulate objects without needing extensive programming about the shapes of objects they would encounter beforehand;
- space shuttles that could dock themselves because they might not need a pilot;
- robots that could clean up toxic-waste spills on their own, or be sent into sites where a nuclear accident had occurred; and
- robots that could assist the disabled.

With more than 30 scientific publications so far, Norman's studies also include the processes of aging and whether



PHOTO BY SHERYL HAGAN-BOOTH

Dr. Hideko Norman participates as a subject in an experiment designed to measure how accurately people perceive distances along the surfaces of curved objects.

and how they affect perception. Research shows that as we grow older, we become more susceptible to falls and injuries. This is a fact that "has major implications for the elderly." Norman questions whether this is due to a decline in motor skills or perceptual skills. "Perhaps as we get older, it becomes more difficult to judge the 3-D position and shape of surrounding surfaces, like the distance to the next step on a staircase," Norman said. "If we could develop a test of 3-D vision that could predict ahead of time who is at risk of a fall, then we could take appropriate measures ahead of time to prevent that fall."

Over the past two years, his lab has tested people

ranging from college-age students to those in their 80s, looking for changes in perception related to age. His research has shown important changes in perception that accompany aging that "warrant further investigation."

"You can never test someone's ability to perceive three-dimensional shape with a standard eye chart. The results of a visual acuity test tell us very little about our ability to perceive 3-D shape," Norman said.

His research in psychology has placed him in high esteem with his colleagues at Western. They recently chose him for the University Faculty Award for Excellence in Research/Creativity for the year 2000. "It's an honor that they would pick me for the award. I didn't expect to be nominated," Norman said.



PHOTO BY SHERYL HAGAN-BOOTH

Apparatus used to cast shadows of 3-D objects onto curved surfaces.

Even as a youngster, Norman seemed destined for great things. One of his hobbies included making short-wave radios from discarded television sets. "People would throw away TVs and I would disassemble them to get the electronic parts. I would then take the parts and make short-wave radios and listen to stations in Europe and Asia. I still use one today; it's a good way to get the news," Norman said.

Norman is also one of six professors participating as mentors in an eight week summer research program funded by a grant from the National Science Foundation. The 12 students selected will work in areas ranging from prenatal development to cognition and perception.

"That kind of research experience helps students get into prestigious graduate programs and facilitates their careers," Norman said. "I'm glad to see that Western values and supports research experiences for undergraduates. That's not true at many other universities."

In addition, Norman said that over the past ten years, virtually 100 percent of Western's experimental psychology master's graduates have been accepted into doctoral

programs. "Apparently Western and the Psychology Department are doing something right."

While robotic technology is being developed and improved in laboratories around the world, Norman said that no robots that exist today have capabilities that even come close to the perceptual abilities of the human visual system. Most, if not all, of the robots today cannot see and perceive the shape of objects on their own. That limits their usefulness to us.

So how close are we to this revolutionary technology? "In the 1960s, almost everyone thought that by the year 2000, we would have robot assistants that could see and do all kinds of things for us. Many engineers and scientists thought that we would understand the process of 3-D shape perception by now," he said. Unfortunately, we still have a lot to learn about how human observers actually perceive shape.

While we may not be at that pinnacle yet, Norman said he thinks it will happen eventually. "I'd certainly be curious to come back in 100, 200 years and see what happens," he said.



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Applied Experimental Psychology Graduate Student Shannon Walker views stereoscopic 3-D images using a mirror haploscope.