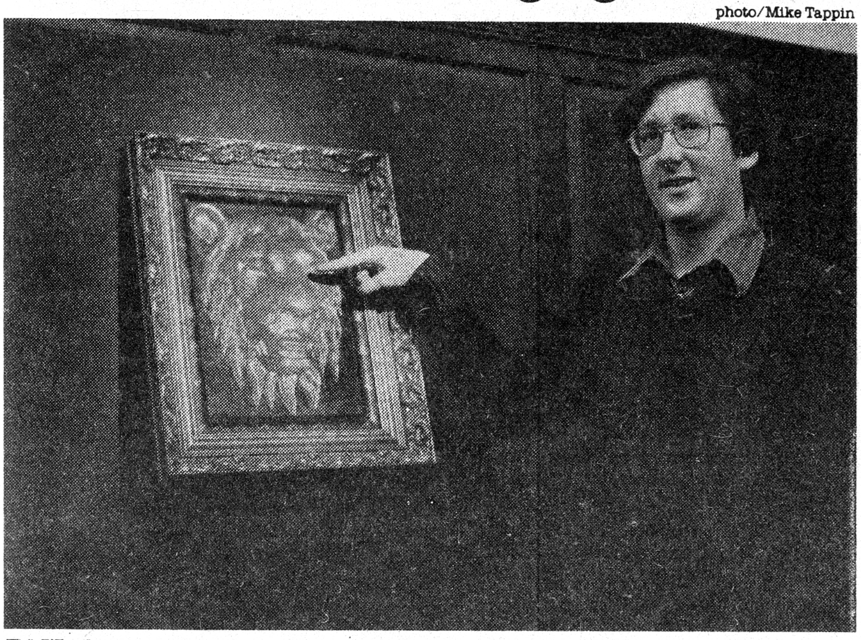
Class Action: shedding light on holography

photo/Mike Tappin



Ed Wesly

Eyes blazing a brilliant red, the lion mounted on the wall glared at me as I approached it. As I got close, I reached out my hand to rub its snout, but even then something didn't seem quite right. A moment later, my fingers had passed intact through the nose and were somewhere inside the animal's skull. Startled, I stopped, and then wiggled my fingers. There was nothing there. I craned my head around for a side view, and suddenly the lion disappeared.

Ed Wesly laughed. "There are only three known copies of this Russian hologram in the free world," he said. "This is actually a hologram of the inside of a casting of a lion's head, but it has been flipped over so it seems to stick out." Wesly, the director of education at the Fine Arts Research and Holographic Center, 1134 W. Washington, had been pointing out the salient features of each of the two dozen exhibits in the Center's small museum, but the lion was by far the most unnerving. It was more riveting than the sparkling hologram of a jewel-studded bracelet, the two-and-a-half frames of the holographic movie, or the platoon of toy soldiers whose front ranks hung in midair about three inches in front of one wall and marched back through it into nothingness.

It was even more interesting than the 360-degree hologram of Dr. Jeong's children, though this was pretty intriguing. Dr. Jeong, a professor at Lake Forest College and a consultant to the Center, invented a form of the 360-degree hologram in 1965. Mounted on a chest-high pedestal, the hologram consisted of a clear plastic cylinder about six inches high that rotated clockwise. Through the cylinder could be seen three whole, animated children. As they spun, they winked, turned their heads, waved, and played peekaboo with the viewer. The hologram had been made, said Wesly, by first making a movie of the children, as they turned, with a camera set to expose three frames per degree of rotation. Each of these 1080 (360 degrees times three frames per degree) frames was then printed holographically through a Rube Goldberg-like, mineral-oil-filled plexiglass lens that compressed each frame into a long, thin strip. These transmission holograms (there are two types of holograms: the transmission type transmits light through the hologram to the eye; the reflection type reflects it back to the eye) were then pasted to the cylinder so that a person looking through it saw the original scene.

The museum at the Center contains examples of most of the things that have been done with holograms so far, a collection that actually is not too difficult to compile. Holography is barely 30 years old – it was devised in 1948 by an English scientist seeking a way to improve the resolution of electron microscope photographs – and it wasn't seriously explored by anyone until 1960 when the laser, with its output of predictably identical – coherent – light waves, made it possible to compare precisely two beams of light.

That is the essence of holography. The process uses no lens. Instead, laser light waves reflected from an object are compared with an undisturbed laser beam. This is done by aiming the reference beam so that its waves cross those reflected from the object. The action at this intersection looks something like the squiggling and jiggling of an AM radio wave on an oscilloscope when someone speaks into the microphone (except that since nothing moves while the hologram is being made, the squiggles stay in the same place – they are standing waves). The film, placed at the intersection of the two beams, codes the jigs and jags into a pattern of light and dark spots.

When light is passed back through the developed film, the pattern of light and dark spots decodes the light back into the reference beam and the object beam. The latter is made up simply of the light waves that bounced off the object, which our eyes recognize as the object itself. Thus, we 'see' the object even though it isn't really there.

There are several interesting corollaries to basic hologram theory. For example, no lens is used, so light waves bounce off an object in all directions and are recorded on all parts of the film. Therefore, all points on the object are recorded everywhere on the film. A hologram sliced in half, quarter, or any number of pieces will show the whole object on each piece – this is a property called redundancy.

Another corollary: if a hologram is flipped over, an object that was, say, three inches behind the film when it was holographed will appear three inches in front of the film, the way the lion did. Or one can project a hologram and then make a hologram of that. Since the projected object is made up of light waves, the film for the second hologram can be placed in the middle of it: thus the second hologram shows part of the object protruding, part receding – like the toy soldiers.

"This one," said Wesly, holding up a three-by-three-inch piece of glass, "was made here in our labs." He tilted it to the light. Hanging in space behind the glass, a pale ceramic box appeared with a dove perched on it. The box and dove were bathed in the full spectrum of color.

"A rainbow hologram," he said with satisfaction. "To get this effect, we holographed the box through a slit, so the slit was holographed too. It's actually hanging there, invisible, in the space between the object and the glass film. The slit diffracts white light into the color spectrum. If I showed the hologram with the same ruby red laser light it was made in, it would act like a crack in a fence: you would only see little horizontal slices of the object through the invisible slit until you got your eye right down to it. Then you would see the whole object."

Wesly became interested in holography at a seminar for photography teachers when Dr. Jeong made two holograms before his eyes. Now, in the courses he teaches, Wesly emphasizes practical knowledge. "A big problem with holography," he said, "is that the literature takes a quantum leap from the most basic books on the principle to abstruse mathematical explanations of the theories." That leap didn't deter Wesly himself; his bachelor's degree is in mathematics. But, he said, "There are no 'hands-on' books to help an experimenter get started making holograms."

Students in his classes, therefore, get to do such things as tinker with the object/reference beam intensity ratio, try out different development and exposure times, and experiment with spatial filters. "There are about 100 to 150 different variables in making a hologram," Wesly said. "If you want to design your own system, you have to know how each of these variables affects the hologram." Eventually, students move up to the top two courses in holography (there are five in all, plus fundamental courses in optics and chemistry), where they pursue esoteric, highly specific subjects of their own choosing, such as what Wesly himself is now doing – experimenting with a nonhardening film fixer to reduce the distortion caused by film shrinkage.

"We want a place where there's a lot of information, and discussion can go on," Wesly explained. "Holographers are still an isolated group. There are probably only about a dozen holographers in this town, plus a few in San Francisco, a few in New York, some in Ohio...."

Wesly put the rainbow hologram back into its envelope. "It takes time to make these things," he said. "This rainbow hologram is the result of about 18 hours of work. There are tons of other ideas floating around – in color holography, radio holography, sonic and X-ray holography – but we need more people to carry them out."

The center launches a fall series of five lectures and demonstrations tonight (Friday) at 7 PM, as Tung Jeong reviews lasers and their uses in a program called **The New Light**. On subsequent Fridays, local experts will discuss such topics as lasers in medicine, lightwave communication, and holographic testing of objects. Two dollars at the door, $8 for the series. 226-1007.

– Kevin Johnson