Diffraction turns a white flashlight into a rainbow.

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Up to Some Optricks in Southern California

Brian Monacelli and Donn Silberman

Optical scientists and engineers are working with the Optics Institute of Southern California (OISC) to create outreach experiences for curious minds across Southern California. In collaboration with local schools and youth groups, these members of the Optical Society of Southern California (OSSC) have volunteered to coordinate interactive demonstrations of optical phenomena.

Recently, they organized the third annual Optricks Days, a two-day program held at the Discovery Science Center in Santa Ana. The March 2006 event lasted two days, with attendance estimated at 2,000 people. The Optricks Days were among the busiest days of the year for DSC employees and volunteers. Science Center exhibits were enhanced with optical systems and tools, including lenses, mirrors, prisms, telescopes, microscopes and spectrometers.

Participating students took part in hands-on demonstrations, in which they studied computer chips with commercial microscopes, watched lens-makers polish glass, and learned how fiber optics work. One exhibit featured plasma-discharge tubes, each filled with a different gas; the students could explore the spectral signature of each via diffraction gratings. Volunteers from Griffith Observatory intrigued the students with small telescopes and charts of the stars and the Martian surface.

In another exhibit, students used a commercial Keplerian telescope (two positive lenses) to view a distant building. Afterwards, they could deconstruct the device on an optical rail, learning how a telescope is made from lenses to produce a magnified, inverted image. Next, the students were shown a 90° prism and a homemade kaleidoscope, which demonstrated how mirrors and prisms could be used to rotate an image.

Finally, the students looked through a commercial monocular that produced a magnified, erect image. When asked to compare the image created by the monocular to that of the two-lens telescope, some students had the insight to predict that there were image-rotating prisms within the monocular. It was impressive how quickly the students learned when they held the optics in their hands.

At the heart of the Optricks Days were the presentations of the Optricks Apprentice, an enthusiastic volunteer who explained how the optical components in the students' take-home packets work. He wore a cloak and pointed hat, and waved a light-up wand. The Apprentice used Fresnel lenses to enormously magnify the faces of a few student volunteers.

During the course of the 30-minute workshop, the students received four Optricks from the "Optricks Suitcase": a transmission diffraction grating ("rainbow peephole"), a small lens ("magic dots"), a liquid crystal ("magic patch") and a polarizer sheet ("magic stripes"). The suitcase was largely adapted from the Optics Suitcase developed by the Rochester section of OSA.

The diffraction grating came with a small flashlight, which enabled the students to see immediately how white light can be spread into a rainbow. The Optricks Apprentice tailored his explanation to the age of the students, asking younger students to name the colors of the rainbow, for example, while challenging older ones to learn about the spectral lines of gases in sodium street lights or neon plasma signs. Only minutes after experimenting with the grating, one student correctly hypothesized that "superbright blue" (high-intensity discharge) headlights would look different from conventional headlights.

In the next demonstration, students were offered small positive lenses with a piece of cardstock that had the periodic table of the elements printed on it with a

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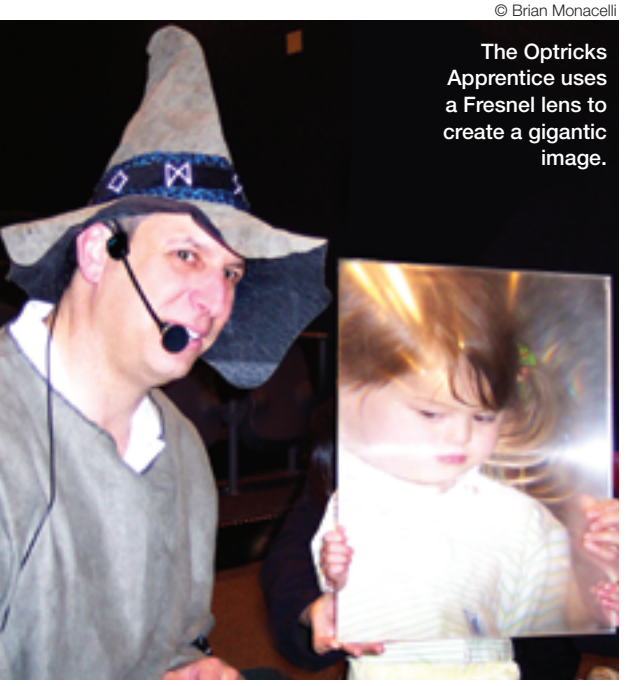

The Optricks Apprentice uses a Fresnel lens to create a gigantic image.

four-color printer. When they looked at the page with the lenses, the four colors of "magic" dots of ink leaped off the page. The Apprentice asked the students to name the colors when viewed normally, and then compare them to those seen when the printout is viewed with the lenses. The Apprentice encouraged the students to look out for other examples of color mixing, such as in the Sunday comics.

While playing with a liquid crystal patch, the students learned how heat from their hand changes the color of the crystal. The Apprentice made an analogy to the LCDs that people use everyday, such as cell phones and video game displays. Some students even examined their own phones with their lenses. The Apprentice discussed the varying selective absorption of the liquid crystal, and offered some examples of the same phenomenon in nature, such as the changing colors of leaves in autumn.

Perhaps the most vibrant demonstration was done on an overhead projector by placing clear plastic utensils between a pair of crossed polarizers. The photoelastic effect yielded a brilliant display of color, and the students could create this effect with their own polarizer and clear plastic.

The Apprentice explained that stresses in the plastic cause light to change its polarization state as it passes through the plastic. To help the children understand this concept, the Apprentice asked some of them to hold the end of a Slinky and wave it up and down to produce a variety of "polarization states." He then drew an analogy to the light passing through the utensils.

Optricks Days is just one example of the many outreach activities that are continually organized by the OSSC and the OISC. For instance, the Optricks Suitcase was recently presented at the MESA Rocket Night Extravaganza, an event coordinated by Roosevelt Elementary School in Compton, Calif., and attended by more than 500 students, parents and teachers.

The more the students learned, the more evident their interest became. With their new optical toys, the students gained a unique perspective into the luminous world around them. One volunteer received this compliment from a fourth grader: "Someday, I want to be able to explain light to my friends just like you do." ◭

The authors would like to thank the many Optricks supporters, including all the DSC staff and OSSC individual and corporate volunteers. All the Optics Apprentices owe gratitude to Dr. Murty V. Mantravadi, "The Wizard of Light," who has been teaching optics to apprentices, coworkers and students since the 1950s.

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[References and Resources]

>> Additional pictures: http://OISC.net/OPTRICKS_Days2006.htm

>> Discovery Science Center: http://discoverycube.org

>> The Optics Institute of Southern California: http://oisc.net

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