Not the Stellafane Way

Here's how to whip up a giant telescope mirror in the 21st century.

THE RECIPE below isn't exactly what the patron saint of Stellafane, Russell Porter, had in mind when he began teaching amateur astronomers in Vermont to build their own telescopes in the 1920s. But it's a regular occurrence at the Steward Observatory Mirror Lab in Tucson, Arizona. And it's the vision of the lab's director, Roger Angel, upon whose shoulders stand some of the world's great telescopes.

During the first half of the 20th century, George Ellery Hale's quest to build ever larger telescopes dominated astronomy. It culminated with the mammoth 200-inch reflector on California's Palomar Mountain, which remained the largest telescope on Earth for more than 40 years. But it was Angel's unconventional approach to mirror fabrication that helped shepherd in a new era of giant reflectors.

Perfected by the mid-1980s, Angel's idea is to cast borosilicate glass in a rapidly spinning oven. When the mirror blank cools, it already has a concave surface close to its final shape, saving countless hours of laborious grinding. After a string of successes that included spin-casting the mirror for a 3.5-meter (138-inch) telescope atop Apache Point in New Mexico, Angel's lab expanded to where it can now spin-cast mirrors more than 8 meters across.

Last April my wife, Wendee, and I were invited to witness a step in the casting of the 8.4-meter mirror for the Large Synoptic Survey Telescope (LSST). With first light expected as early as 2016, the LSST will be powerful enough to image almost 10 square degrees of sky down to 25th magnitude in 15 seconds with a CCD camera having an incredible 3.2 gigapixels. This remarkable telescope will be able to survey the entire visible sky from its mountaintop home in Chile every three nights.

That isn't all. As explained on page 30 of this issue, data gathered by the LSST, unlike that from previous professional telescopes, will rapidly be made available over the Internet for everyone to use. It's a plan that ushers in a new era for astronomy. Discovering novae in the Andromeda and Triangulum spirals and other nearby galaxies will be just the beginning of what future amateurs might do if they tap into the pipeline of data flowing from the LSST. And what a boon it will be for professional astronomers hoping, at last, to understand the estimated 95% of the unseen universe accounted for by dark matter and dark energy (August issue, page 30).

Recipe

MIRROR MAKING 101: PREPARING A SINGLE 8.4-METER DISH.

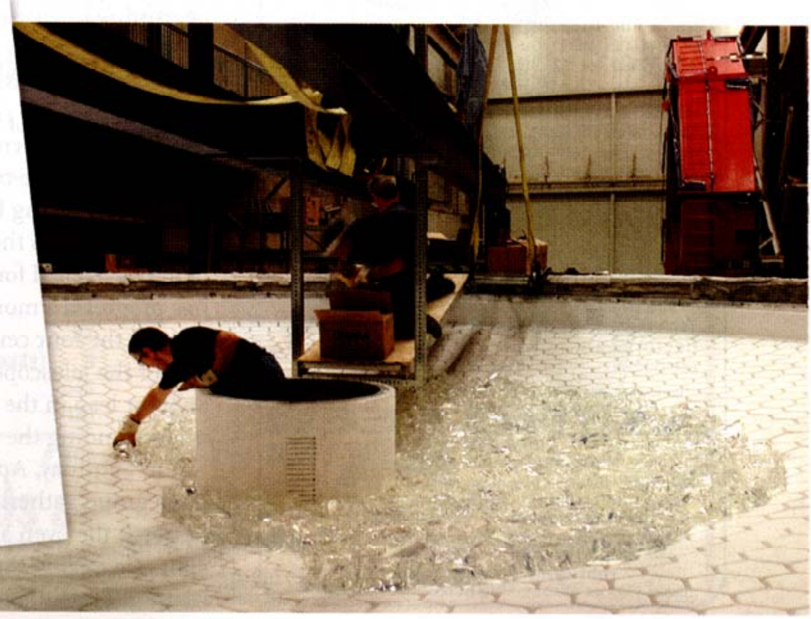
Step 1: Gather 24 metric tons (about 53,000 pounds) of Ohara E6 borosilicate glass broken into thousands of melon-size chunks. Inspect each one and discard any having the slightest impurities or internal stresses. Set pieces individually into ceramic-lined mold.

Step 2: Place mold in oven and heat to 1,180°C (2,160°F).

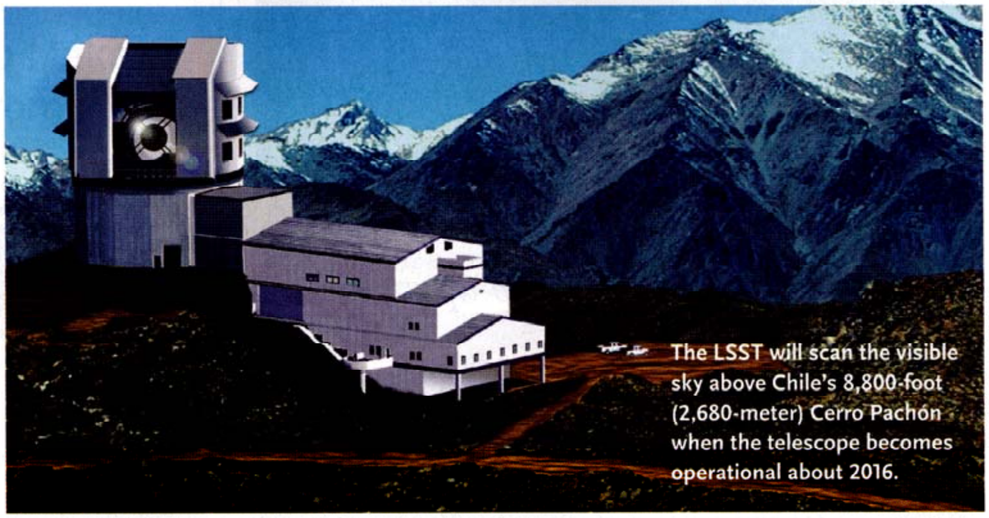
Step 3: After 5¼ days, when glass has melted, begin spinning oven at 7 revolutions per minute. Continue spinning for 3 days until surface of molten glass has shape of a parabola.

Step 4: Allow to cool for about 100 days.

Step 5: Remove from mold, grind, polish, coat with aluminum, and place in freshly made telescope. Will serve astronomers for generations to come.



RAY BERTRAM, STEWARD OBSERVATORY



The LSST will scan the visible sky above Chile's 8,800-foot (2,680-meter) Cerro Pachón when the telescope becomes operational about 2016.

MICHAEL MULLEN DESIGN / LSST CORP.

Having grown up with stories of the 200-inch telescope, I wish I could have seen any stage of its fabrication. It would have been something to have watched the pouring of the great glass disk at the Corning Glass Works in New York. Or to have joined the crowds waving at the mirror as it chugged along on its cross-country rail journey to the California Institute of Technology's optical facilities in Pasadena. Or to have been on one of the winding switchbacks as the mirror made its journey up Palomar Mountain on a wet and foggy morning in November 1947. But those things happened before I was born.

I was a small child in Canada when Kitt Peak National Observatory was founded in southern Arizona in the late 1950s. Two decades later, however, I was beginning my life in Arizona when Dan Brocious, then the new public information officer for the Multiple Mirror Telescope, showed me a tiny silicon chip no bigger than a little fingernail. "This is the future of astronomy," he correctly predicted. Just as digital imaging has progressed from that tiny CCD to the gigapixel behemoth being developed for the LSST, astronomy has progressed more in the past 30 years than in the four centuries since the invention of the telescope. The LSST will be yet another leap in the forward march to our understanding the universe.

On Saturday, April 12th, we joined a large group gathering at the Mirror Lab to watch the oven as it reached its fastest spin rate during the 8.4-meter mirror's casting. The finished disk will be especially noteworthy because it'll serve as two optics in one. The outer portion of its surface will act as the LSST's primary mirror, bouncing light up to the secondary. The secondary will reflect light back to the giant disk's central 5.2-meter-diameter area, which will be ground and polished to a different curve that the outer ring and act as the telescope's tertiary mirror, feeding light into the camera.

Just as it had done for other major mirror castings, the University of Arizona marked this event with a celebration. We met a cadre of donors, many of whom knew few details about the science they were funding. And there were the scientists, some of whom seemed more relaxed when keeping to themselves. But the mixture worked. The presentations were at a perfect level for people with an inquiring, though nontechnical, interest in the molten glass spinning like a merry-go-round next door. This is the Arizona way: more than anything else, it provided a chance for those closest to the action to interact.

Sometime in the next decade, as the sky darkens over remote Cerro Pachón in Chile, the LSST will open its immense eye for the first time. Astronomers will begin a search for objects and ideas as yet unimagined. As the universe expands, our understanding of it is just beginning the race to keep up. ✦

*Veteran astronomy writer **David Levy** keeps watch on the sky over his own home in Arizona with a variety of telescopes and cameras.*