No country for old telescopes

Van Vleck Observatory sits on Foss Hill on the campus of Wesleyan University in Middletown, Connecticut. OLIVIA DRAKE/WESLEYAN UNIVERSITY

At Wesleyan University's Van Vleck Observatory, a century-old 20-inch refractor is experiencing a rebirth. The fate of many other classic refractors is not so bright.

by Joshua Sokol

It was October 1998 when Chris Ray's footsteps first echoed in the dome overlooking Andrus Field — the central lawn — at Wesleyan University in Middletown, Connecticut. Above him loomed a 28-foot-long (8.5 meters), 2-ton refracting telescope that had seen better days.

Ray, an expert in museum restoration, could see that the instrument's bearings had rusted. Paint was peeling off the scope. "I just had a sense of desolation looking at this telescope," he says. "It looked abandoned."

It had once been cutting edge. In the 19th and early 20th centuries, long refractors like the one at Wesleyan were points of pride for dozens of American universities — chances to explore nature at its grandest scales and to loudly signal a commitment to that endeavor. But the second half of the 20th century saw big refractors stagger into obsolescence.

Now the institutions that house these relics face tough choices. Although refractors offer crisp views of celestial wonders like Saturn, they're too outdated to draw research grants from major sources like the National Science Foundation. Often, they hog prime campus real estate. Sure, they're historical — but they're also hard to use, even dangerous. And renovating one can cost half a million dollars or more.

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For much of the past decade, Ray and his business partner, Fred Orthlieb, a retired engineering professor at Swarthmore College in Pennsylvania, have traveled the country restoring these defunct marvels. Roy Kilgard, a research and support astronomer in charge of the public outreach program at Wesleyan, invited Ray to visit, and his first sight of the refractor was a reminder that not all historic telescopes die a dignified death. Even fewer are granted second chances.

At Wesleyan, a storied instrument stood at a crossroads, where a final decision to renovate or replace had to be made. "At some point, a lot of these places are just going to shut the doors," Orthlieb says. "Some already have."

The age of giant refractors

Wesleyan's refractor is exactly what the word *telescope* brings to most people's minds. A lens focuses light down the length of a tube, which teeters at its middle on a counterbalanced mount. Gears in the mount let the telescope point at and track the sky. At the end of the scope, a photographic plate or an eyepiece for visual observing intercepts the converging light from the primary lens.

Refractors, seen even now on college seals as a stand-in for *science*, were half lab equipment, half status symbol. Products of the Enlightenment, they came to represent modernity itself. In 1764, Harvard University's scientific instruments were lost in a fire; none other than Ben Franklin went on a shopping spree in London and shipped back a set of new, shiny brass refractors.

This is how Wesleyan University's 20-inch refractor looked in May 2014, just before it would be taken down for restoration. Workers already had refinished the dome's interior and floor. OLIVIA DRAKE/WESLEYAN UNIVERSITY

The rear element of the Wesleyan scope's 20-inch Alvan Clark doublet lens rests on blocks after the restoration team removed it from its cell and Chris Ray initially washed it. The "V" on the lens' side marks the forward direction. OLIVIA DRAKE/WESLEYAN UNIVERSITY

By the 19th century, as technological advances allowed glass lenses and the refractors built with them to get bigger and better, American universities itched to get their hands on them. "To appear legitimate on a world stage, you had to have a telescope," says David DeVorkin, a historian of astronomy at the Smithsonian Institution's National Air and Space Museum.

At Wesleyan, three generations of telescopes trace to this era. First, the university bought a 6-inch, 7-foot-long (2m) refracting telescope from a craftsman in Paris in 1836, following Yale and preceding Harvard as one of the first American universities to get its hands on one. Astronomy rose in the public consciousness while also syncing with the liberal arts ideal. Then American telescope makers, long overshadowed by their peers across the Atlantic, got in on the trend in the years after the Civil War.

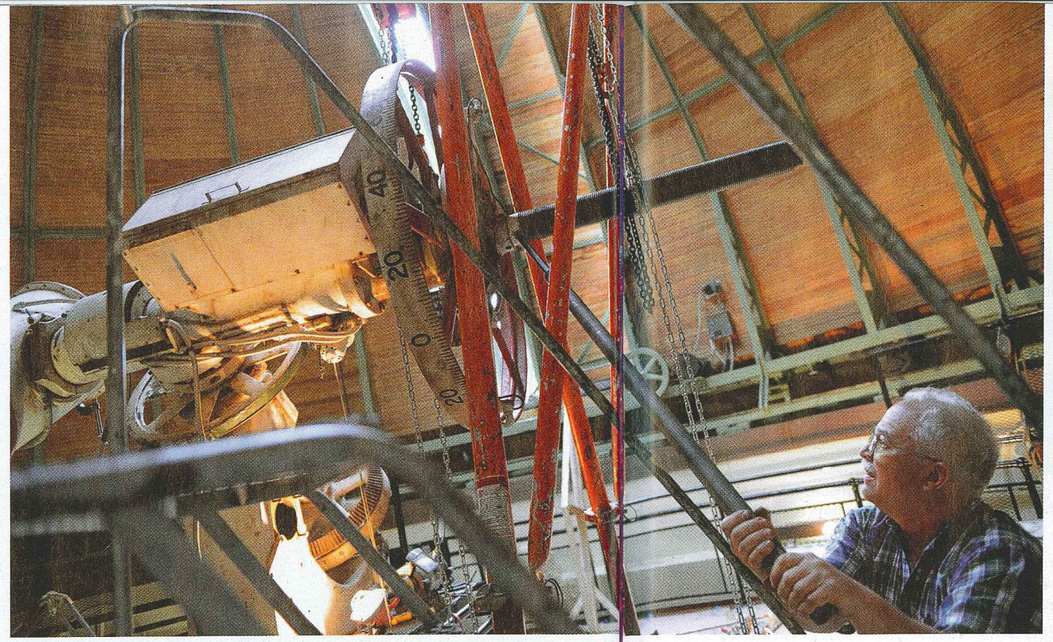
Foremost among them was Alvan Clark & Sons, a workshop in Cambridgeport, Massachusetts, renowned for precision and artistry alike. In 1868, Wesleyan stocked its observatory with Clark instruments, including a 12-inch, 15-foot-long (4.6m) scope that later passed to Miami University and then into private hands. And as the century progressed, Clark lenses bulged against the limits of engineering. On five occasions, the Clarks sculpted the biggest telescope lens in the world, often breaking their own record and necessitating gargantuan tubes to match the long focal lengths.

Twenty-six inches. Thirty inches. Thirty-six inches. Then, in 1897: a 40-inch lens for Yerkes Observatory in Wisconsin. The largest lens ever used for astronomical research, it is so huge that the light it focuses converges 62 feet (19m) away.

As a small liberal arts school, Wesleyan was priced out of the competition for these behemoths. But when the university set out to acquire a bigger, better telescope in the 1910s, it looked to the same trusted brand. The lens, ground by hand and tested by eye at Alvan Clark & Sons, arrived late but 20 inches in diameter — an inch and a half bigger than ordered. It was an auspicious start.

Measuring the stars

Before an assembled crowd in June 1916, astronomer Frederick Slocum dedicated Wesleyan's Van Vleck Observatory, which was named for John M. Van Vleck, who taught astronomy and mathematics at the university from 1853 to 1912. Although the Clark lens had not yet arrived on campus, the building already was impressive. Perched inside its spotless dome on Foss Hill, the lens-less telescope sprawled above a movable floor (courtesy of the Otis Elevator Company) that could rise or fall to bring observers level with the eyepiece.



Fred Orthlieb strains to unscrew the 20-inch refractor's right ascension counterweight bar from its threaded socket at the end of the declination axis. The bar itself weighs 200 pounds (90 kilograms). OLIVIA DRAKE/WESLEYAN UNIVERSITY

Astronomical research and the teaching of students would go hand in hand at Wesleyan, Slocum told his audience. But in an age of giant telescopes, even a 20-inch refractor was only modest. Worse still, New England's weather is notoriously dreadful for astronomy.

To make an impact, the Van Vleck Observatory would have to focus on a single fundamental question. By collaborating with Yerkes, England's Royal Greenwich Observatory, and a consortium of other schools, Wesleyan researchers would measure parallaxes — a way to gauge how far away stars are through the tiny displacements in their positions caused by Earth's orbital motion around the Sun. The astronomers would find the distances to the stars, Slocum said — and that's exactly what they did.

From the 1920s until the 1990s, when the European Hipparcos satellite took up the baton by measuring precise distances to more than 100,000 stars, Wesleyan's refractor toiled away at the problem. It was used to train generations of young astronomers and for fun and outreach, too: In the 1950s, popularizer Walter Scott Houston peered through it to write his "Deep Sky Wonders" column for *Sky & Telescope*.

Astronomer Bill Herbst, a professor at Wesleyan and former director of Van Vleck Observatory, recalls the halcyon days. When he arrived at Wesleyan in 1978, the telescope was still a parallax factory, still in its prime, operating under the careful guidance of Director Arthur Upgren.

But decades of old-fashioned astrometry, the careful by-hand measurement of the distances between stars on photographic plates, came at a cost. For the results to stay consistent, the telescope couldn't be modified. "It was protected like it was made of gold," says Herbst.

No single development killed the research use of the Wesleyan refractor and its peers around the country. Instead, National Science Foundation funding slowly dried up. Reflecting telescopes, which use mirrors and not lenses to collect light, became more and more ubiquitous largely because craftsmen could make them much bigger. Photographic plates were being changed out for modern camera chips. And the very untouchability that kept the Wesleyan scope's measurements stable over time also deferred maintenance, which aided its undoing.

Old telescopes are like old automobiles, says Ray: Without careful attention to preservation, time can kill them. They must be lubricated and not allowed to rust. The domes can't leak. The lenses should be taken out and cleaned every three years or so.

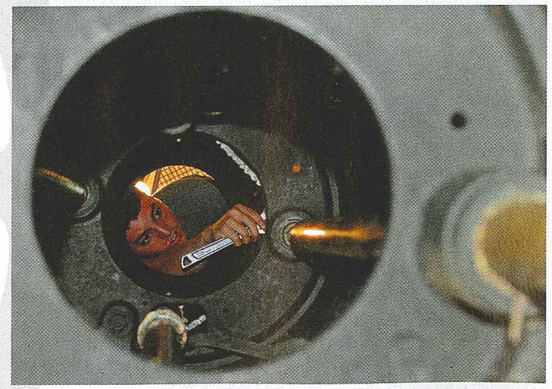
Yet another threat is botched surgery. In the late 1960s, an engineering firm put Wesleyan's telescope under motorized control. The company replaced the original hand-turned wheels that moved the scope and then threw out those trustworthy old parts. Many of the updates have since fallen to shreds, leaving the Wesleyan refractor working but a shell of its original self.

Only the dedicated work of folks like Kilgard had kept the scope operational, though not as an instrument for serious science. Still, students taking introductory astronomy classes used the 20-inch during observing sessions, and members of the general public got to peer through its ancient glass during monthly viewing nights hosted by the Astronomical Society of Greater Hartford.

A lost generation?

Looking around the country, old refractors like the one at Wesleyan face a diversity of fates. They can be discarded entirely, with the observatories torn down and the instruments shelved or sold to private collectors. Storied astronomy departments at the University of Pennsylvania and Princeton University followed this path, as did Beloit College in Wisconsin, whose observatory building now survives only as limestone blocks in a retaining wall.

They can haunt as dusty crypts few ever enter. At Swarthmore College, the famous 24-inch Sproul refractor (see "Triumph to tragedy" on p. 48) sits unused inside a green dome. Orthlieb and Ray tried to fix it, but renovation plans were scrapped when the last astronomer loyal to it died in the early 2000s.



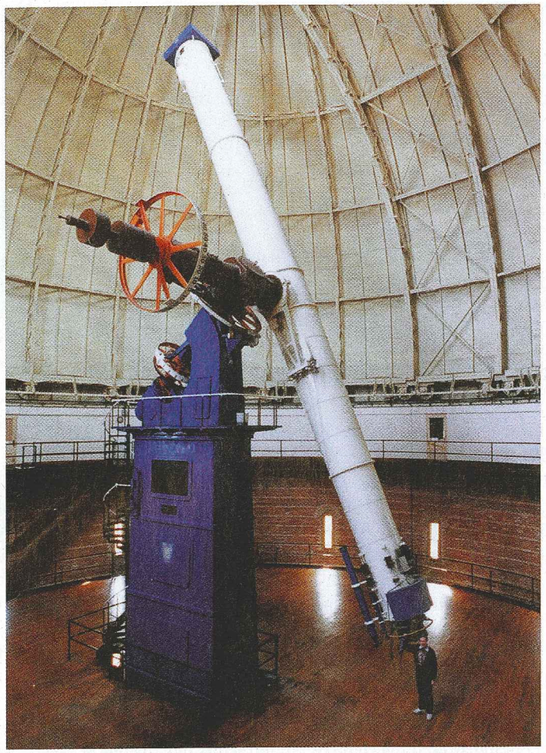
With wrench in hand, Julian Dann works inside the rear end of the optical tube assembly's back half. The four bronze rods seen here originally provided about 3 feet (1 meter) of coarse focus. OLIVIA DRAKE/WESLEYAN UNIVERSITY

Becca Hanschell removes fasteners from the forward part of the optical tube assembly's back half so she can take out the electrical cable shields inside the tube. OLIVIA DRAKE/WESLEYAN UNIVERSITY

THE BIGGEST REFRACTORS IN THE UNITED STATES

The United States currently has 11 refracting telescopes sporting primary lenses 20 inches in diameter or larger, topped by the 40-inch scope at Yerkes Observatory in Wisconsin. All of them remain under control of their original owners except for the one at Roper Mountain Science Center in Greenville, South Carolina, which started out as the main instrument at Princeton University's Halstead Observatory in New Jersey.

Name	Location	Lens diameter	Built
Yerkes Observatory	Williams Bay, Wisconsin	40 inches	1897
James Lick Telescope Lick Observatory	Mount Hamilton, California	36 inches	1888
William Thaw Telescope Allegheny Observatory	Pittsburgh, Pennsylvania	30 inches	1914
U.S. Naval Observatory	Washington, D.C.	26 inches	1873
Leander McCormick Observatory	Charlottesville, Virginia	26 inches	1884
Lowell Observatory	Flagstaff, Arizona	24 inches	1894
Sproul Observatory	Swarthmore, Pennsylvania	24 inches	1911
Roper Mountain Science Center	Greenville, South Carolina	23 inches	1881
Chamberlin Observatory	Denver, Colorado	20 inches	1891
Chabot Observatory	Oakland, California	20 inches	1914
Van Vleck Observatory	Middletown, Connecticut	20 inches	1922



The world's largest refractor, a 40-inch behemoth, resides at Yerkes Observatory in Williams Bay, Wisconsin. Astronomer Kyle Cudworth provides a sense of its mammoth scale. RICHARD DREISER/YERKES OBSERVATORY

YERKES OBSERVATORY

Alvan Graham Clark (left) poses as assistant Carl Lundin polishes the 40-inch lens that would become the heart of the Yerkes Observatory refractor.

They can malinger as sources of shame. "Our telescope has been forgotten for over 20 years," writes the head of the physics department at Brooklyn College in New York in response to a request to visit the school's observatory. "An exterior hole in the building let the birds in and completely messed up the room. There is nothing respectable to see."

Or they can be granted new lives. In the 1970s, with its observatory in a state of decay, Brown University in Rhode Island considered selling the lot to McDonald's. Now, thanks to the efforts of volunteers and a 1990s restoration, guests pack public open houses waiting their turn to look through the 12-inch Ladd refractor.

A rebirth of hope

In June 2014, Ray returned to Middletown with Orthlieb. Their mission: to save the Wesleyan refractor. Herbst had hired the two after convincing university administrators to reinvest in the telescope. Given that the observatory is an icon of the campus, the administration realized it would be an embarrassment to let the big white dome and the instrument inside it rust away.

"Some telescopes get saved; all too many don't," says Bart Fried, founder and president of the Antique Telescope Society, an organization of historians, engineers, and other enthusiasts.

"They're almost too big to throw away," he continues, referring to the giant refractor at Yerkes Observatory and its smaller cousins at Swarthmore and Wesleyan. "You can't inconspicuously sweep Yerkes under the rug. Or Sproul under the rug. Or Van Vleck under the rug."

But the decision to bring back an old university refractor isn't as simple as it might seem. It costs at least a few hundred thousand dollars. It entails rehabbing a building, fixing the scope, painting, and meeting electrical and safety codes. It requires hiring engineering firms or expert enthusiasts like Ray and Orthlieb. And all of this is for what's essentially a giant obsolete piece of lab equipment.

"I can't get hysterical about the loss of every observatory," says Sara Schechner, a historian and curator of Harvard's Collection of Historical Scientific Instruments, in an office that features no fewer than five globes depicting the celestial sphere. Clearly she's a partisan: Schechner married her husband in the observatory at Wellesley College in Massachusetts.

She is sympathetic to the calculus facing college administrators, who have to weigh the cost of refurbishing an old refractor against buying a newer, user-friendly instrument. In addition, any institution with a large refractor must worry about liability. If it becomes unbalanced, even a healthy refractor can swing with punishing momentum. "The guy before me broke his neck," says DeVorkin, whose first job had him operating the 36-inch refractor at Lick Observatory in California, then the world's second largest. Steering a telescope by hand isn't exactly risk-free.

It's also hard to strike a balance between authenticity and pragmatism. A telescope restored with historical accuracy, including authentic drives and setting circles, has a much steeper learning curve than modern computerized systems. And even if the restoration faithfully reproduces the old instrument, it's not a great teaching tool for future astronomers — the field has moved on.

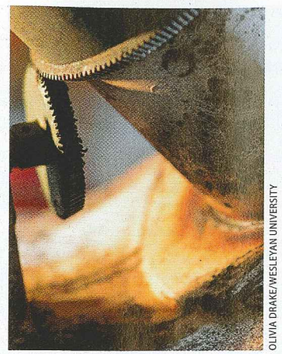
On the other hand, a new telescope is much less romantic. No whirring gears, no hand-turned wheel that drives the scope into position, no steampunk brass — and crucially, in the age of modern cameras and other instruments, often no eye-to-tube experience.

The way Orthlieb and Ray fix telescopes — what they are doing at Wesleyan — is often something in between. "A kind of Frankenstein monster" is what Schechner calls it. But in this fix, Orthlieb and Ray are transforming the true "Frankenstein monster" — the one created by the relatively clumsy 1960s modernization — into a hybrid featuring classic major components (including the Clark optics, optical tube assembly, and pier) married to a modern and sophisticated operating system.

Renovating the telescope like this may sound like degrading it, says Ray. But in bright urban areas, the days of pointing a telescope toward a familiar constellation to home in on a target are long gone. Even in Middletown, which is darker than many cities, modern technology will simplify and speed up observing.

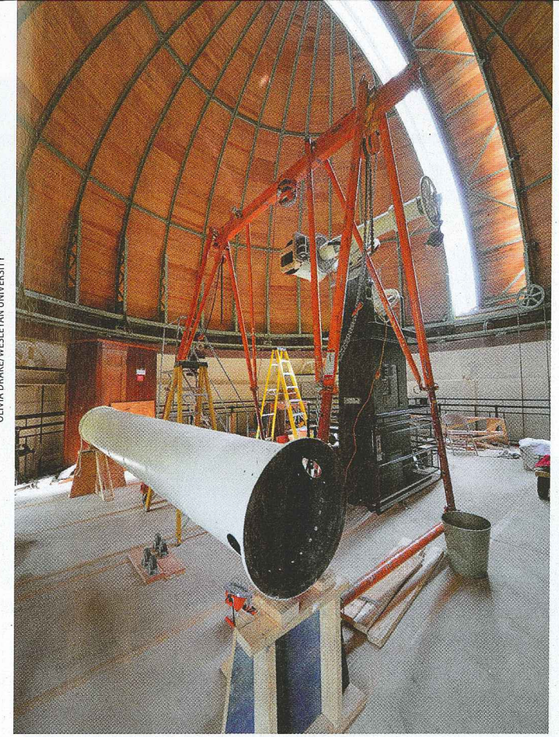
The new old Wesleyan refractor, when it emerges, will be a careful compromise of history and pragmatism. The goal is to preserve the telescope's past while ensuring its usability for another 100 years. "It's going to be a telescope that's pretty easy to use," says Herbst. "It's going to provide really unparalleled views."

The restoration itself offers unique opportunities, too. Decades of Wesleyan undergraduates have used the telescope. Precious few have seen its inner workings. And fewer still have helped shepherd it from senescence to a hopeful future.



OLIVIA DRAKE/WESLEYAN UNIVERSITY

These corroded gears originally drove a dial on Wesleyan's 20-inch refractor that showed where the scope was pointing.



By June 2015, the restoration of the 20-inch Van Vleck refractor was nearing completion. Here, the repainted front half of the optical tube assembly appears in the foreground; the renovation team expects to install it by the end of August. LAURIE KENNEY/WESLEYAN UNIVERSITY

Return of an icon

Work on the restoration began in June 2014. At the start of the project, the telescope hung by ropes as a small team prepared to dismantle it. Orthlieb and undergraduate students Becca Hanschell and Julian Dann took out alternating screws to avoid straining the structure. They then pulled out a stubborn cylinder that weighed more than 200 pounds (90 kilograms). "We had to ease it out by crowbars, banging it," Hanschell recalls. "It comes loose. One bang, and it goes *'pop!'* And it just swings. It was kind of scary."

Ray and Orthlieb then made exacting measurements and took the scope apart. Over the next few months, Hanschell and Dann worked under Orthlieb and Ray's guidance. Although the students had studied astronomy, not engineering, they caught on fast.

On sunny days, Hanschell and Dann kept the slit of the dome open to take advantage of the natural light. The sunbeam coming through the open slit turned slowly, a sundial to mark the time of day. On rainy days, they'd turn on all the lights, even the emergency ones, to brighten the closed space. It was still dim. They could hear the rain pounding on the outside of the dome. "It'd feel like you were beneath this huge sea," says Dann.

Over the summer, they painted the scope's components white instead of black. Ray came briefly, too. He spent his visit hunched over the Clark lens carefully, lovingly cleaning rust away from the edges and then polishing the glass.

By summer's end, Hanschell and Orthlieb had put much of the telescope back together. After returning to their workshop at Swarthmore, Orthlieb and Ray set to work fabricating the scope's new drive gears.

Wesleyan's refractor is now en route to a happy exhumation, currently scheduled for completion in time for the observatory's centennial in 2016. But what happens to telescopes elsewhere is up in the air. For now, Orthlieb, Ray, and others with the Antique Telescope Society are there for the universities that want them. Like the telescopes they fix, the gears still turn. "We're antiquarian — we're antiques," says Orthlieb. "But our brains are still alive, and we know how to do this stuff."

TO SEE SOME TIME-LAPSE VIDEOS OF THE RESTORATION WORK AT VAN VLECK OBSERVATORY, VISIT **www.Astronomy.com/toc.**

TRIUMPH TO TRAGEDY

In conversations with historians, the consensus is clear: No story of 20th-century refractors can ignore the saga of Peter van de Kamp. It's a tale in which Wesleyan's Van Vleck refractor plays a pivotal role.

In the 1960s, the Dutch-born van de Kamp made headlines worldwide. He claimed to have discovered the first extrasolar planet (or planets) by measuring slight wiggles in the position of the nearby red dwarf Barnard's Star through the 24-inch Sproul refractor at Pennsylvania's Swarthmore College. It fell to observatories like Wesleyan's with similar telescopes to confirm the discovery.

They couldn't. At Wesleyan, professor Heinz Eichhorn saw no such planet — it just didn't exist. Perhaps the lenses at Swarthmore had shifted subtly during a 1949 cleaning, creating a spurious wiggle. Van de Kamp, by all accounts a lovely man, went to his grave stubbornly insisting he was right.

AIP EMILIO SEGRÈ VISUAL ARCHIVES, JOHN IRWIN SLIDE COLLECTION

Peter van de Kamp, seen here in 1976, believed he had found at least one planet circling Barnard's Star through the 24-inch Sproul refractor at Swarthmore College.

Even though Wesleyan's telescope had helped resolve the debate, the reputation of refractors as precise instruments took a big hit — one from which they perhaps never recovered. The Smithsonian Institution's David DeVorkin goes even further: "If I were really wanting to be provocative, I would say van de Kamp helped to kill the long-focus refractor." — *J. S.*