Old Glory, New Glory

The Star-Spangled Banner gets some tender loving care

By CORINNA WU

From a custom-made gantry, conservators examined and vacuumed the Star-Spangled Banner last December after taking it down from its display at the Smithsonian's National Museum of American History. They later rolled up the flag and moved it to a specially built lab for more-detailed work.

Jeff Tinsley, Smithsonian

In 1814, as a young nation embroiled in a war with Great Britain, the United States needed a symbol to rally around. It found one courtesy of a Washington lawyer named Francis Scott Key.

Key boarded a British ship flying a truce flag in Baltimore's harbor to negotiate the release of a prisoner. When the enemy fleet around him began raining cannonballs on Baltimore's Fort McHenry, Key was detained on the ship, unable to do anything but anxiously watch the perilous fight until the dawn of Sept. 14, 1814.

The British warships finally retreated, their attack unsuccessful. As the legend goes, Key peered through a spyglass and saw, in the distance, a huge American flag flying over the battered but still-standing fort. The sight inspired him to pen the patriotic poem that—set to the tune of a British drinking song—eventually became the United States' national anthem.

One hundred and eighty-five years later, that famous flag is still around, but the stripes aren't quite so long, and the stars aren't as bright. Originally measuring 30 by 42 feet, about the size of half a tennis court, the flag today is truncated; it's missing the last 8 feet across its stripes. Also, one star has mysteriously disappeared. The woolen fibers have become fragile from exposure to moisture and light. Holes and rust spots mar the fabric.

Now, the Smithsonian Institution's National Museum of American History in Washington, D.C., the flag's home for the past 35 years, is using modern—even space-age—technology to ensure that the banner may be proudly hailed for centuries to come.

The museum has begun an $18 million, 3-year project to preserve the Star-Spangled Banner. In late May, art conservators partially unfurled the flag onto a specially constructed 32-by-66-foot table, where, wearing surgical scrubs, they will delicately clean and mend it.

The project is the largest textile-preservation effort ever undertaken by a museum. "Our goal is to stabilize the flag, not make it look like new," says Suzanne Thomassen-Krauss, the project's chief conservator. Through the examination she's leading, one of unprecedented detail, the museum not only hopes to save the flag from further deterioration but also to learn more about its past. Moreover, the experience gained could help scientists protect other historical textiles from the ravages of time.

Lt. Col. George Armistead, the commander of Fort McHenry, in 1813, commissioned a Baltimore flag maker named Mary Pickersgill and her 13-year-old daughter Caroline to sew the flag that came to be known as the Star-Spangled Banner. It cost the military $405.90.

After the battle that Key witnessed, Armistead probably just took the banner home with him, says Lonn Wood Taylor, the museum's historian for the conservation project. The flag was passed down in the Armistead family until 1907, when Eben Appleton, Armistead's grandson, loaned it to the Smithsonian Institution in Washington.

Appleton made the flag a permanent gift in 1912, but before it was displayed, the Smithsonian hired a Boston flag restorer named Amelia Fowler to apply her patented sewing technique to the banner. She and a team of seamstresses removed an old canvas backing that had been sewn on in 1873 and stitched on a new linen backing, using thread dyed to match the stars, stripes, and blue field.

By stitching through the fabric, Fowler and her assistants put a dense network of linen thread on the front of the flag, says Taylor. The colors of those threads have faded, producing a dingy look. Structurally, they're troublesome too.

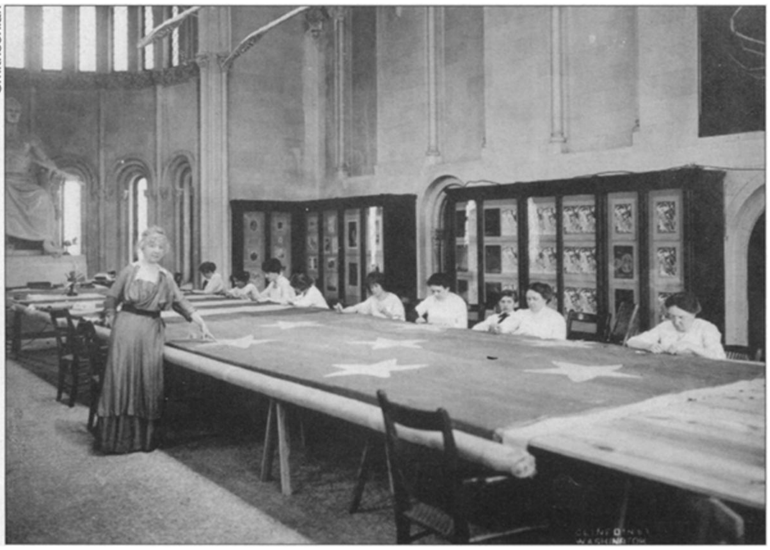
"Linen was a good choice, since it's durable and there's not much elongation," he says. "The inconsistency of the stitching, however, becomes a problem over time." The heavy backing, because it pulls on some areas of the flag more than others, may have weakened the fabric, so conservators have decided to remove it.

A foot-square patch of red where the conservators have snipped the stitches looks much brighter than the rest of the stripe surrounding it. Unrolling the flag as they go, the museum workers plan to clip every one of the estimated 1.7 million stitches that hold on the linen backing. Given that there are 12 to 14 stitches per square inch and that conservators can snip "3 square feet on a good day, 1 square foot on a bad day," says Taylor, that effort alone will take at least a year.

The linen backing will then be history, but the conservators have yet to decide what kind of backing or support for the flag they will use. In fact, they are taking advantage of the snipping period to plan many details of the project's later stages.

The undertaking's main objective is to stop the flag's deterioration. The fact that the Star-Spangled Banner stayed in private hands for so long and was displayed only on patriotic occasions probably saved it from completely falling to pieces, historians speculate. However, the Armisteads did indulge requests from War of 1812 widows who wanted to bury their husbands with a piece of the flag, a practice known as "souveniring," says Thomassen-Krauss. Consequently, the banner is shorter than it was originally.

The Smithsonian displayed the flag in its Arts and Industries Building until 1964, when it moved the banner to its current home across the National Mall in Washington. There, the flag hung in the entrance hall, exposed to pollution blowing in from the street, dirt coming off millions of visitors, and oily grime floating up from machinery such as escalators. In 1982, the museum gently vacuumed the surface to remove surface particles, but the flag clearly needed more extensive care.


Smithsonian

Flag restorer Amelia Fowler led a team of seamstresses in attaching a linen backing to the Star-Spangled Banner in 1914. They made an estimated 1.7 million stitches—all of which will be removed during the current preservation project.

In 1996, a group of 50 experts convened at the museum and hatched a plan to preserve the Star-Spangled Banner. A crucial first step was to assess the damage in detail.

"It's hard to know with an artifact this size what the condition is beyond the level you can see with the eye," says Thomassen-Krauss. "It's easy to say that it's just made of cotton and wool, but [after years of environmental stress] every fiber is different."

Art historians have long used infrared imaging of small samples to authenticate pigments of paintings (SN: 3/13/99, p. 166). Thomassen-Krauss turned to this technique, both its conventional form and a technology that scientists at NASA's Goddard Space Flight Center in Greenbelt, Md., had developed to examine distant planets.

Wool is a protein like hair. When moist wool gets a dose of sunlight and oxygen, the fibers essentially get split ends, Thomassen-Krauss says.

To assess the damage to the flag, wool researchers Ian Weatherall and Fenella France of Dunedin, New Zealand took small fiber samples for analysis by infrared spectrometry, electron microscopy, mechanical testing, and determination of amino acid content.

Furthermore, the New Zealand researchers have teamed up with scientists at the USDA's Eastern Regional Research Center in Wyndmoor, Pa., to conduct a lab study to learn more about how light weakens wool. Conservators can use such information to better preserve wool artifacts, such as the flag.

The scientists plan to expose coarse wool fibers—resembling those in the Star-Spangled Banner—to artificial sunlight. Using infrared spectrometry, they will correlate photochemical damage with the fibers' loss of strength.

"Light degradation is a very powerful process," says William N. Marmer, who heads the Hides, Lipids, and Wool Research Unit in Wyndmoor. His co-worker on the project, textile scientist Jeanette M. Cardamone, also serves on a committee for the preservation of the Shroud of Turin.

Like museum conservators, the wool industry might reap some benefits from the project. It might learn how to protect wool draperies, carpets, and upholstery, all of which tend to disintegrate after too much sun.

The study could even explain what happens to wool while it's still on the sheep. The ends of the wool are always exposed to the sun, says Marmer. That leads to a condition called tippiness. "The ends of the fiber behave differently in dyeing and are weaker than the rest of the fiber," he explains.

While Marmer and Cardamone work with infrared spectrometers that only scrutinize small samples, Goddard scientists are using a camera they recently developed that can take images of large objects like the Star-Spangled Banner.

John J. Hillman and David Glenar had devised a camera called the Acousto-Optic Imaging Spectrometer, which uses sound waves to select infrared wavelengths. Used with telescopes on Earth or as an instrument on board a spacecraft, the camera can identify chemical compounds by the characteristic ways in which they reflect infrared light. The Goddard team is developing the technology to go into an instrument that could determine the mineral composition of rocks on Mars.

Testing the camera on an old, stained tapestry, Hillman says, "I demonstrated that there were oil signatures that were invisible to the naked eye." The infrared camera can also identify spots that collect moisture from the air, which leads to damage of the wool fibers.

The Goddard device measures reflected light in the near-infrared range instead of the thermal infrared, heat-related light emitted by an object. Conventional spectrometers that rely on this longer-wavelength thermal infrared "cannot identify contaminants on the flag because they are the same temperature as the flag itself," says Thomassen-Krauss.

Because of logistics, Hillman had to do his analysis while the flag still hung in the museum. Devising a method to take images of the three-story flag "took a lot of orchestrating," says Hillman.

A lighting designer at the National Air and Space Museum created a scaffold for the camera and a light bar that could be raised and lowered on an elevator mechanism. "It was a trellis of lights—like a theatrical rock concert," says Hillman. The lamps, filtered to remove all extraneous ultraviolet and visible light, gave the flag "an eerie red glow," he adds.

Hillman divided the flag into 72 sections and took about 30 shots of each at different infrared wavelengths over two intense weeks in November 1998. He marvels at the proximity of his subject. "Here's this monstrous flag," Hillman exclaims. "Not only is it on the same planet, but it's in the same room. As an astronomer, I'm not used to that."

Although exciting, taking the images was only the first hurdle. The data from the nearly 2,500 images will take most of the summer to analyze fully, he says.

Although in need of a good laundering when it was taken down from the museum entry hall after Hillman's work, the Star-Spangled Banner couldn't simply be dropped off at the dry cleaners. In December 1998, museum employees gingerly laid it flat on a temporary platform for an inspection. The conservation team drew a map of all the holes, tears, and stains on every square inch of the flag.

Mary Ballard, Smithsonian

A sample of dust vacuumed from the Star-Spangled Banner includes clay particles, vegetable matter, synthetic fibers, and lint magnified 300-fold.

Conservators found Armistead's signature on the flag, as well as a needle left from its 1914 restoration. A puzzling red chevron on one of the white stripes, Taylor thinks, was an aborted attempt to sew the Armistead family monogram onto the flag. "The surface of the flag is like an archeological dig," he says. "It contains traces of everything that happened to it."

From its years of hanging in the museum, the banner has collected enough dust and grime to make a vacuum cleaner salesman jump for joy. One of Thomassen-Krauss' colleagues says that micrographs of the dust collected from the surface look like "Bourbon Street after Mardi Gras."

The conservators gave the flag a light vacuuming before they wound it onto a big cardboard tube like a giant roll of paper towels. They then moved it upstairs into a new conservation laboratory that doubles as an exhibit.

The lab is a huge, climate-controlled clean room not unlike ones used to make computer chips. A large, adjustable table supports the flag as conservators care for it. A gantry, or rolling bridge, hovering above the table allows up to seven conservators to work, lying flat on their stomachs, just 4 inches from the flag's surface.

The bridge won't deflect or vibrate, says Anthony Maher, a Washington-based project manager from the architectural and engineering firm KCF-SHG, which designed the room. A steady platform helps prevent workers from damaging threads of the flag as they work on stitches and stains.

The amount of illumination in the lab is kept low—as dim as the dawn's early light, one might say. Filters over lightbulbs remove ultraviolet radiation, and light reaches the flag only indirectly after bouncing off the walls. "Light probably causes the most damage over time," says Thomassen-Krauss. Visitors can peer into the lab through a glass wall.

On the basis of what the infrared camera has found, the conservators will choose cleaning fluids for each stain. Workers will drip the fluids through the fabric and remove the fumes and dirt with large "elephant noses," hoses connected to a powerful exhaust system.

The conservators still aren't sure how they will eventually protect and display the newly freshened flag. "Research is ongoing," says Thomassen-Krauss.

The museum might sandwich the banner between two layers of a sheer, meshlike fabric and stitch them together through the flag's holes and tears. Conservators are also thinking about eventually encasing the relic in a sealed chamber filled with an inert gas, such as neon, to prevent oxidation.

Until then, museum visitors can watch the conservators at work. If everything goes according to plan, their treatment will ensure that the Star-Spangled Banner gallantly waves for generations to come. □

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