

# Case Study

## Anchors Aweigh! High Speed Scanner Captures Nuances of Civil War USS Monitor Artifact



### New Leica Scanning Technology Delivers a Bounty of Benefits for Non-Contact Data Acquisition

by Belinda Jones

The treasures that lie beyond the doors of the Mariners' Museum in Newport News, Virginia, are sure to capture the heart of any history buff. The museum is filled to the crow's nest with prized artifacts that celebrate the spirit of seafaring adventure. Visitors from around the world experience over 60,000 square feet of gallery space filled Civil War ironclad USS

Monitor artifacts and archives, paintings, small craft with rare figureheads, handcrafted ship models and much more. Perched on a 550-acre woodland park, the museum was recently the center of a major data acquisition effort to capture and digitally preserve a key artifact retrieved from the shipwrecked USS Monitor.



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## Leica Scanning Technology Delivers a **Bounty of Benefits for Non-Contact Data Acquisition**

On a cold New Year's Eve in 1862, the USS Monitor encountered a storm and sank sixteen miles off the coast of Cape Hatteras, North Carolina. The wreck of the USS Monitor was discovered in 1973, and two years later was designated America's first National Marine Sanctuary. The site is protected and managed by the National Oceanic and Atmospheric Administration's (NOAA) National Marine Sanctuary Program. On behalf of the federal government, NOAA designated the Mariners'

Museum in 1987 as the repository for artifacts and archives from the Monitor. In 1987, NOAA retrieved the Monitor's anchor, the first of the large objects to be recovered from the site. From 1998 to 2002, NOAA and the US Navy conducted large-scale diving operations to reinforce the Monitor's collapsing hull and to recover significant artifacts and components, including the propeller, steam engine, revolving gun turret and guns. Today, the Mariners' Museum houses more than 3,000 artifacts and archives that tell the stories of the unique vessels that engaged in the first naval battle between two ironclad warships, CSS Virginia and USS Monitor.

Dealing with antiquities that slowly erode over time, the Mariners' Museum and its partners at NOAA turned their eyes toward high-precision scanning technology to digitally capture its artifacts. One artifact on the priority list was the historic anchor. The anchor's surface is very brittle after 140 years underwater, and has been conserved using electrolytic reduction and coated with a microcrystalline wax. The anchor is currently on display in

the Mariners' Museum's Ironclad Evidence gallery.

"For conservation purposes, our ability to perform 'current state' vs. 'original state' inspection is critical to preserving our high-value cultural materials," explains Marcie Renner, chief conservator. "If a crack develops on the surface of an artifact, we can determine if the situation is worsening. Once the digital data is archived, the integrity of artifacts like the anchor can be inspected on-demand with a very high degree of accuracy." Data acquisition of historic relics has many challenges for the metrologist. First, the artifact cannot be touched by hand or instrument. Second, the anchor could not be moved or staged. And thirdly, the job would need to be accomplished in two days, primarily during normal museum hours.

Jack Shry and Denny Warren of Leica Geosystems (Lawrenceville, GA) and senior metrologist Steve Hand of MAGLEV Inc. (McKeesport, PA) were not daunted by the two-day endeavor. Due to record-breaking data acquisition capabilities of





the new Leica T-Scan, the team could digitally capture the surface rapidly in a non-contact fashion. Gathering 7,000 points per second from the anchor's intricate surface, the hand-held scanner allowed the team to capture the 3D object in a fast, unfettered manner. The ultra-high speed scanner works in tandem with the Leica Laser Tracker, a portable coordinate measurement system (PCMM) used for industrial measurement and inspection applications. The Leica Laser Tracker yields the fastest measurement cycle in the business for high point density at 3,000 points per second. Metrologists can acquire precision data within a measurement volume of up to 30m. The operator can use the handheld scanner to digitize both small and large objects, and gather millions of 3D points in just minutes with an accuracy of better than 100 microns.

Using the scanner, reverse engineering and inspection processes require much less time for set-up and object preparation, often up to a 50-percent reduction. Leica Geosystems' unique ability to combine laser tracking functionality with probing and scanning capabilities in the largest measurement volume garners multi-faceted benefits in this type of data gathering environment. This same technology is being used by major manufacturers in aerospace, automotive, and general engineering industries who require portability, the highest precision and non-contact measurement capability.

"The surface data acquired during this project was very comprehensive... very low in noise, no post processing, and the data was immediately available for viewing," states Jack Shry, Leica Geosystems East Coast manager. "In fact, at 7,000 points per second, the end result looked just like a picture. We required only three setups due to the flexibility of the hand scanner. The scanner's four faces provide multiple angles of access to the object's face. With the laser tracking technology, you can develop a local coordinate system, then tap right into a larger coordinate system."

A specialized metrology software, SpatialAnalyzer™ (New River Kinematics, Williamsburg, VA) was used for the data acquisition project. New River Kinematics developed a robust interface for Leica's

new Local Positioning Technologies, the Leica T-Scan and the Leica T-Probe, in addition to the existing laser tracker software program. Bruce Thomas, NRR specialist in hardware-software interfacing, provided on-site technical support during the two-day undertaking. The Leica T-Scan worked so intuitively that museum conservators each had a chance to use the device and take part in the landmark project. The device provides user-friendly pre-alarm – a warning buzzer – to let the users know if they are getting close to breaking the connection to the tracker. Collecting highly accurate data in hard-to-reach areas to achieve total 3D coverage of the anchor was made easy by the tracker's ability to be relocated to various vantage points, and collect multiple data sets in the same coordinate system.

created by the MAGLEV team that can be used for measurement, documentation, animation, and archival records. This digital record of the anchor's construction can also be used to monitor the anchor's condition, and to reproduce physical prototypes for merchandising and exhibit purposes.

Hand said, "At MAGLEV, we conducted 0.5 mm processing of the data, and concluded with nearly 6.5 million triangles to represent the high-definition surfaces. The data file was nearly 200MB in size. The initial renderings and animations produced for the Museum were exceptional due to the quality of the scanned data. You could literally see the forging marks on the anchor."



"When using the Leica T-Scan, you feel as though you are holding a brush and painting dimensions upon the anchor's surface," said Steve Hand. "The museum staff could easily participate, and the museum patrons were also very interested in the process. It is a very enlightening visual experience to watch the real-time results on the computer monitor and see the most minute details on the anchor's exterior. The entire project took eight and a half hours of scan time. The accuracy was superlative."

At the end of the project, Hand returned to MAGLEV with anchor data in tow. The surface data accumulated from the scanning session formed the foundation of very detailed 3D computer models

The Mariners' Museum and NOAA are constructing the new \$30 million USS Monitor Center opening on March 9, 2007. A full-scale replica of the Monitor warship will serve as the dynamic focal point of the Center. The Leica data acquisition work, and other scanning projects, will directly contribute to the Museum's ability to create exciting exhibits and rich visualizations of these historic artifacts. "From a legacy standpoint," concludes Shry, "the Mariners' Museum now has an accurate 3D CAD model that will enable them to perform best-fit operations years down the road to determine if the anchor has experienced damage or deterioration. You could process the data down to the 0.1mm level, and the slightest bruise can be detected."

### **The Mariners' Museum**

For over seventy years, the history of the ocean and its relationship with humankind has been told and displayed in one of the largest maritime museums in the world. The Mariners' Museum, an educational, non-profit institution accredited by the American Association of Museums, preserves and interprets maritime history through an international collection of ship models, figureheads, paintings and other maritime artifacts. The Museum is open from 10 A.M. until 5 P.M. daily. Closed Thanksgiving Day and Christmas Day. For information, call (757) 596-2222 or (800) 581-7245, or write to The Mariners' Museum, 100 Museum Drive, Newport News, VA 23606. [www.mariner.org](http://www.mariner.org)

### **Leica T-Scan**

Since its introduction a little over a year ago, Leica T-Scan has been enthusiastically received by a number of customers in the automotive and aerospace industries. The commercial successes of the Leica T-Scan has encouraged the Metrology Division of Leica Geosystems to perform pro bono activities for a number of museums and other altruistic causes. The Museum of the Opera di Santa Maria del Fiore in Florence, Italy has relied on the Leica T-Scan to faithfully replicate some of its most endangered artwork, assuring its continued preservation for the benefit of future generations. In Texas, USA, the world's fastest 4-cylinder aircraft, "Polen Special," was fully digitized to enable reverse-engineering work on its aerodynamics and various engine parts.

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