

When the USS Missouri was decommissioned in 1992, the 887-foot-long Iowa-class battleship looked tired. Its worn and pitted teak deck had supported hundreds of naval officers and their crews through three wars spanning five decades. It was on this deck that Gen. Douglas MacArthur accepted Japan's unconditional surrender in a ceremony on Sept. 2, 1945, ending World War II and securing the USS Missouri's place in history. However, the ensuing years and battles had left multiple scars on the noble ship—particularly in the form of rust.

The USS Missouri had actually been decommissioned once before, in 1955. Thirty-one years later, the Missouri underwent an extensive modernization of its weaponry. Equipped with four Tomahawk missile launchers, it was recommissioned and called into

action for Operation Desert Storm. Six years later, in 1992, "Mighty Mo," the last battleship built by the United States, was finally allowed to rest.

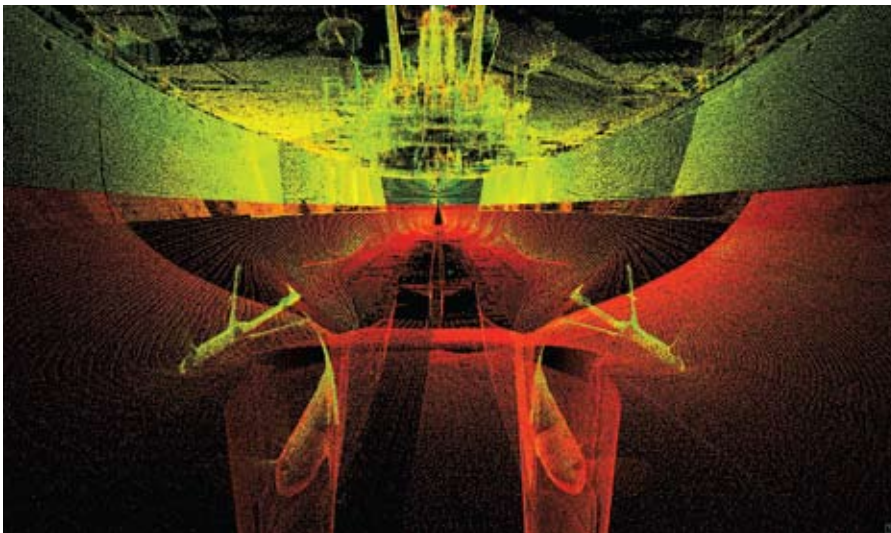
For the next several years, the magnificent vessel remained docked at the Puget Sound Naval Shipyard in Bremerton, Wash. Then, in May 1998, the Navy officially granted the battleship's care to the nonprofit USS Missouri Memorial Association Inc. The donation launched a new mission for the historic battleship as a floating World War II museum, docked next to the USS Arizona on Pearl Harbor's Battleship Row. The museum opened on Jan. 29, 1999, a testament to the vision and perseverance of the association's directors. But the directors had an even bigger vision in mind—one that involved repairing and preserving the battleship for generations to come.

'Capturing' the MIGHTY MO

BY MARK EVANGELISTA

Laser scans and holograms add a new dimension to the recently refurbished historic battleship.





Opposite: The USS Missouri dwarfs a laser scanner ready to capture the historic ship that served its country in World War II, Korea and the Persian Gulf. Left: The Missouri's exterior hull, imaged from the inside, was taken just aft of the propellers and rudders. Below: A point cloud shows the bridge and surrender deck of the USS Missouri, the site of Imperial Japan's unconditional surrender, which ended World War II.

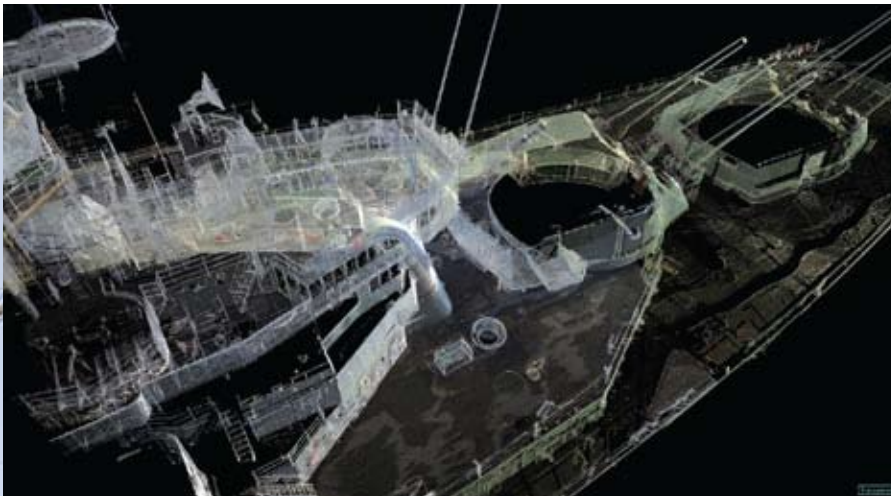
dent of Smart GeoMetrics, a division of Houston-based laser scanning firm Smart MultiMedia, at the Historic Naval Ships Association conference in Alabama. Smart GeoMetrics had scanned the interior of another historic battleship, the USS Texas, earlier in the year, and Lasater was eager to demonstrate the results.

After seeing the photographic panoramas and video flythroughs, the association directors were impressed. The technology offered the potential to improve the overall visitor experience at the museum. If they didn't act then, they probably wouldn't have the chance in the future. "There is no way to complete an accurate scan of an entire ship while it is in the water," Lasater says. "Not only is it impossible to image areas below the waterline, even on a calm day, the tiniest movements of the water and ship would degrade scan accuracy."

The budget for the preservation project was already set. But the association directors decided they had to make the documentation project work. Through an extraordinary amount of teamwork, the project was funded at a level that was acceptable to all participants, and Smart GeoMetrics began honing its strategy.

Calling in the Big Guns

The documentation effort would be the last part of the preservation project before the Missouri was returned to its home on Battleship Row in January 2010. Smart GeoMetrics and its team would have a four-day window to scan the vessel as scaffolding and protective covers were removed. The massive endeavor would require three scanning crews, each equipped with a Leica HDS laser scanner, to complete the project. A fourth crew was assigned to create and maintain the survey control network. "The



A War on Rust

That vision was realized in October 2009 when the Missouri was moved to Pearl Harbor Naval Shipyard's largest dry-dock facility for a three-month, \$18-million preservation project. The project included inspecting and refurbishing the hull, sandblasting and repainting the ship's exterior, replacing rusted steel, and installing a system to monitor corrosion. It also included a comprehensive documentation project that incorporated 3D laser scanning, high-dynamic-range photography and traditional surveys. "Having the battleship Missouri in dry dock provided a unique opportunity to completely scan the ship while it was out of the water," says Michael A. Carr, president and CEO of the USS Missouri Memorial Association. "It was an opportunity we will not see again for decades and certainly one we did not want to miss."

A month before the preservation project began, Carr and other association directors had met Richard Lasater, presi-





USS Missouri Quick Facts

USS Missouri (BB-63)

Class: lowa-class battleship

Length: 887 feet

Height: 209 feet from keel to mast

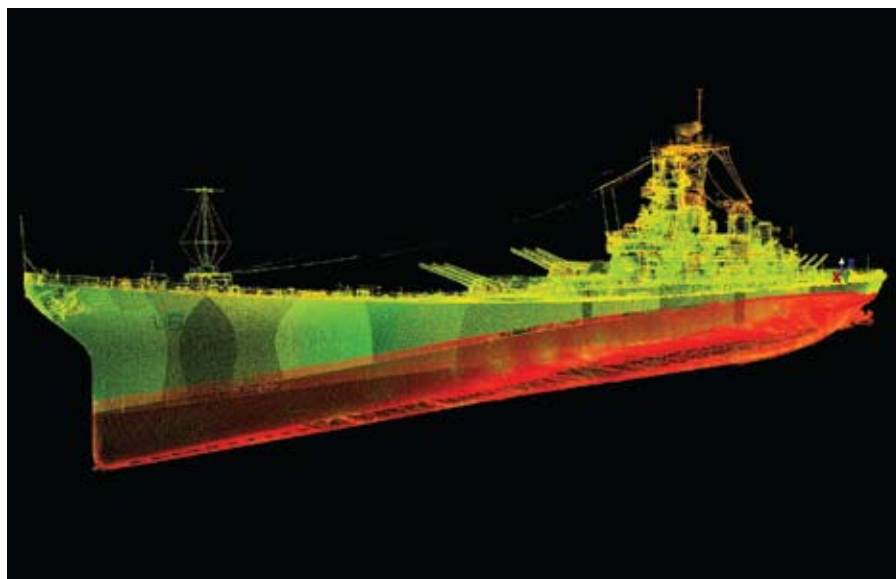
Beam: 108 feet

Weight: 58,000 tons (full load);
45,000 tons (unloaded)

Speed: In excess of 30 knots (35 mph)

- lowa-class battleships were designed for speed and firepower.
- Designing the Missouri took 175 tons of blueprint paper.
- The ship was built in three years and required more than 3 million “man-days” to complete.
- Only four lowa-class battleships, including the USS Missouri, were built during World War II.
- The Mighty Mo is 5 feet longer and 18 feet wider than the RMS Titanic.
- If you could stand the ship on end, it would be 332 feet taller than the Washington Monument.
- Mighty Mo’s trademark feature is its set of nine 16-inch guns. Each barrel is approximately 67 feet long, weighs 116 tons, and can fire a 2,700-pound shell 23 miles in 50 seconds with pinpoint accuracy.
- The Missouri was the last U.S. battleship to be launched and the last to be decommissioned.

Source: www.ussmissouri.com



Above left: Scan team member Donald Axtell positions a Leica HDS 6000 laser scanner near a commemorative plaque on the surrender deck of the USS Missouri. **Top:** A point cloud of the USS Missouri’s port bow from below reveals a virtual snapshot of the historic naval vessel. **Bottom:** A plan view of the powder handling area in turret No. 2 displays a projectile storage area in the upper outer ring.

Missouri is a very, very big ship, and we only had four days to complete an estimated 14 days worth of work among an army of shipyard workers,” Lasater says. “The ship’s location in Hawaii also made logistics a bit challenging.”

However, Smart GeoMetrics was up to the task. The firm quickly assembled a team of HDS professionals from Meridian Associates in Houston and As-Built Modeling Services Inc. in nearby Pearland, Texas, with Houston-based Mustang Engineering Inc. providing special assistance.

The team arrived onsite January 3 and established a control network of more than 400 points. Crews then captured scans at 160 locations on and around

the ship’s exterior and took thousands of photographs—5,400 in all. “The documentation teams were really moving fast on this project, and not all of the ship was accessible at the same time,” says Jonathan White, a senior project manager for Meridian, who headed up one of the scan crews. “We were working in and around dockyard preparations to return the ship to sea.”

By January 6, one day before the Missouri was scheduled to leave dry dock, the scanning and photography work was finished. “Ships such as the Missouri entail a great combination of grace and beauty combined with an industrial structure that comes out very well in scan data,” Lasater says. “This was an exciting project that just

Workers scramble to complete the scan project while the USS Missouri is in dry dock.



enhanced, and special touches have been added to improve the ship's capabilities as a venue for special events. But the Missouri Memorial Association directors and the Smart GeoMetrics team are still working behind the scenes brainstorming new ideas to create and maintain a fitting memorial worthy of the battleship's legacy. "I am very happy with what is being produced and excited to start planning for how we can use it here to improve the overall visitor experience," Carr says. 🌐

Mark Evangelista is a writer for Smart MultiMedia/ Smart GeoMetrics (www.smartmm.com). More information about Meridian Associates can be found at www.meridianassoc.com, and more details about Zebra Imaging are at www.zebraimaging.com. The USS Missouri Association's Web site is www.usmissouri.com.

would not have happened if such a great team of companies and professionals had not been able to collaborate and contribute their expertise."

With the scans in hand, the team turned its attention to the next phase of the project—turning data into deliverables.

A Lasting Legacy

The scans of the battleship generated billions of data points that the team immediately began processing into point clouds, CAD drawings and 3D models.

The team also decided to take the deliverables one step further by adding holograms, a capability provided by Austin, Texas-based Zebra Imaging. "The technology from Zebra Imaging is so compelling," Lasater says. "Zebra agreed to provide

the initial examples [at no charge] as part of the team. However, the Missouri Memorial Association immediately realized the value of the technology and is already working with us to provide specific exhibits and materials."

This project marks the first time holograms have comprised part of an archival record. The results of the entire documentation project will be used by the USS Missouri Memorial Association as a historical record and for ongoing maintenance and educational purposes.

On Jan. 30, 2010, the Battleship Missouri Memorial officially reopened to the public looking much like the day it was first launched 66 years ago. The freshly painted steel glistens in the sunlight. The teak deck gleams. Tours and signs have been