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Also visit:
www.directdimensions.com

Contact:
Michael Raphael, President
410-998-0880
Harry Abramson
Dir. of Business Operations

Tomb of Unknowns Gets New Lease on Life:
Digital Copy of Cracked Tomb Enables Creation of Exact Duplicate.

The Tomb of the Unknowns is cracked. Located in Arlington National Cemetery, the monument honors unidentified Americans killed in battle and attracts 4 million visitors per year. The crack which circles the monument 1½ times has raised concerns that it takes away from the national symbol of pride and also poses a risk of structural damage. In 2001, officials at the cemetery approved a project to make an exact digital copy of the tomb which would then be used to carve an identical new tomb out of marble from the original quarry.

On November 30, 2004 Maryland-based Direct Dimensions, Inc. <http://www.directdimensions.com/> used specialized scanning cameras, lasers, and portable coordinate measuring machines to digitally measure every aspect of the Tomb.

"Our advanced 3-D imaging technology allows us to document objects down to the last intricate detail. The 3-D digital model contains more information than a photograph by showing the precise dimensions of an object," explains Michael Raphael, president, Direct Dimensions. "We can view complex objects such as the Tomb of the Unknowns from different angles on the computer screen and recreate it down to the last indentation on the surface."

Here's how the scanning process works: Direct Dimensions, Inc. measures in three-dimensional space – x, y, and z – using advanced scanning systems. The process uses a mechanical "arm" guided over the object with a laser scanner attached to the end to collect 3-D data without contact. "The scanner is like the 'barcode' scanners we see at the grocery store," notes Raphael. Putting data together like a virtual puzzle, engineers create an exact digital model. What makes this extremely visual technology so remarkable is its ability to pick up fine details, such as sculpted lines, engraved names, even barely visible marks so that the "copy" is an exact replica—something that could never be accomplished with conventional measurement methods. As data is collected, the object becomes highly visible on screen and can be manipulated and studied in remarkable detail.

Direct Dimensions has worked with historical subjects before. The firm was engaged by Cornille-Havard Bell Foundry in Normandy, France to scan the Liberty Bell in order to create the *Normandy Liberty Bell* which was dedicated on June 6, 2004 in honor of the 60th anniversary of the invasion of Normandy. It was also the first – and only – firm to scan the Lincoln Memorial in Washington, D.C., a project that was implemented soon after 9/11. "In the unlikely event that these precious monuments of our history are destroyed, we can recreate them," adds Raphael. The company has also scanned the original Wright Brothers propellers.

This 21st century technology is also being used to save other historic structures, including one of the most architecturally significant buildings in the United States, the Monumental Church in Richmond, Va., designed by Robert Mills, the first native-born American to train as an architect. (Of note, in later years Mills designed the Washington Monument.)

This endeavor is critical because the marble monument is decaying rapidly due to pollution. Within a decade, historians fear, the original monument will disintegrate. With computer graphics, however, technicians can "restore" missing or damaged areas of the building on the computer screen. The resulting model can be used to renovate the building down to the last chisel mark. The project is part of a larger renovation project through the Historic Richmond Foundation to renovate the Monumental Church.

"It's common for marble statues to disintegrate over time, a process called sugaring," says Raphael. "By capturing the precise specifications of this priceless monument, we can recreate it in its entirety." While photographs and video can document the monument to some degree, only this digital technology allows for exact reproduction of every angle – down to elements that are 20 percent of the size of a single strand of human hair.

The first phase of the reproduction is completed. The monument was laser scanned on-site in Richmond and the data analyzed to create a "virtual" repaired original computer model. Then a half-size prototype was milled in highly compressed wood. One can easily see the intricate carvings as well as names chiseled into the monument. The prototype wood model is available for viewing in Direct Dimension's office in Baltimore, MD.

The firm has measured the one-of-a-kind $3 million Cunningham Car, NASA space shuttle components and the interiors of helicopters, trucks, planes and school buses. The firm worked with the Israeli Navy to create a custom solution for the measurement and analysis of large naval ship propellers. Other projects include a re-creation of Leonardo daVinci's "The Perfect Horse," and Olympic kayak paddles. It has also re-created human ear forms and knees for prosthesis purposes**.**

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