From 1501 to 2001: The Digital Michelangelo Project

Using high tech equipment to gain insights on ancient masterpieces

By Jeremy Ginsberg and Laura Jungman

Visitors of the Galleria dell'Accademia in Florence frequently depart with postcards or small plastic replicas of its crown jewel—Michelangelo's David. But in 1999, some American students departed the museum each morning with a much different souvenir: a cluster of hard disks containing precise 3D scans of the sculpture. A month later, the students of Stanford University's Digital Michelangelo Project had collected enough scans to produce a high-resolution model of Michelangelo's legendary sculpture.

Professor Marc Levoy conceived the Digital Michelangelo Project **(graphics.stanford.edu/projects/mich)** in 1997 as an application of Stanford's recently developed 3D scanning technology. By creating models of Michelangelo's sculptures, he hoped to push the limits of technology while building the world's first digital archive of sculptures. The Digital Michelangelo team spent two years developing the machines and software needed for the task, including a 24-foot tall scanner that weighs over 1,800 pounds. Using a stripe of laser light, the scanner can see almost every detail on the sculptures.

In January 1999, a team of 30 students and faculty worked nights scanning in the museum for weeks, avoiding the throngs of tourists who descend on Florence to view the David.

The Digital Michelangelo Project, Stanford University

Some components of the 1,800 pound, 24 foot scanner.

The team scanned ten different sculptures and collected 250 gigabytes worth of data. Using these models, art historians can experience Michelangelo's masterpieces anywhere in the world.

The Galleria dell'Accademia plans to install a multimedia viewing center so that tourists can have access to the virtual sculptures. By enhancing the real museum with a "virtual museum", tourists will be able to view the David from angles that would otherwise be impossible in reality.

Now that they're back from Italy, Levoy and the team will take the raw data—some 2 billion polygons and 7,000 color images for the David alone—and build 3D models of the sculptures. •

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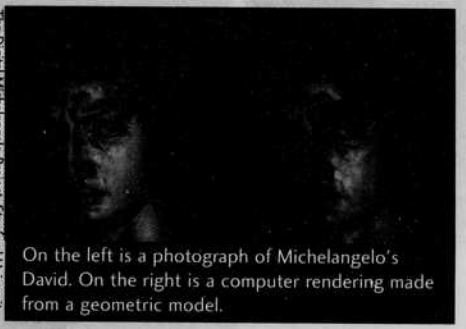
art world's understanding of the sculpture on its head.

The Digital Michelangelo Project made some new discoveries about the David such as the fact that historians had incorrectly measured the statue's height. It's actually 17 feet tall, a significant difference from the 14 feet that art historians have been quoting for centuries.

It was also revealed that David's eyes don't look in the same direction. Levoy believes that Michelangelo did this intentionally to maximize the effect of the profiles. The right side of David's face looks triumphantly at Goliath, while the left side of his face is a traditional Roman profile.



The Digital Michelangelo Project, Stanford University

On the left is a photograph of Michelangelo's David. On the right is a computer rendering made from a geometric model.

Dana Katter, who volunteered for the midnight scanning shift, describes scanning as "the chance of a lifetime." With researcher Unnur Gretarsdottir, she used a smaller, more flexible scanner to access parts of the sculptures that the larger scanner could not reach. Gretarsdottir admits that "scanning was incredibly tedious and time-consuming, but it was a wonderful experience."

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It took Michelangelo Buonarroti three years to complete the David, and he started in 1501 **(michelangelo.com)**. It took Levoy about the same amount of time to turn the

Scanning the sculptures was just the beginning of this ambitious project—the next step is putting the digital images together. Assembling the hundreds of scans is like "trying to solve a jigsaw puzzle in 3D, where none of the pieces fit perfectly" said graphics student Matt Ginzton. He dedicated much of his time on the project to creating software that helps assemble the pieces. The software was designed to piece the scans together using clues such as the chisel marks which remain on the sculptures.

Paul Debevec /The Digital Michelangelo Project

To facilitate scanning horizontal crevices like David's lips, the scanner head can also be rolled 90 degrees, changing the laser line from horizontal (shown here) to vertical.

Piecing together the past

As a side project, Levoy and his team spent 24 hours a day for 3 weeks imaging the Forma Urbis Romae, a marble map of ancient Rome that dates back to approximately 200 AD. The huge map (45 x 60 feet) used to hang on the back wall of the Roman census bureau and showed the infrastructure of ancient Rome in excruciating detail until it fell and was destroyed.

Approximately 15 percent, or 1,163 slabs, of the map has been recovered, and it is in 1,163 pieces. A puzzle since it's discovery in the Renaissance, some fragments are several feet long and weigh up to 150 pounds, not an easy feat to piece it back together.

Levoy hopes that by scanning the fragments, and then subsequently writing the required algorithms, they will be able to use technology to piece it back together.