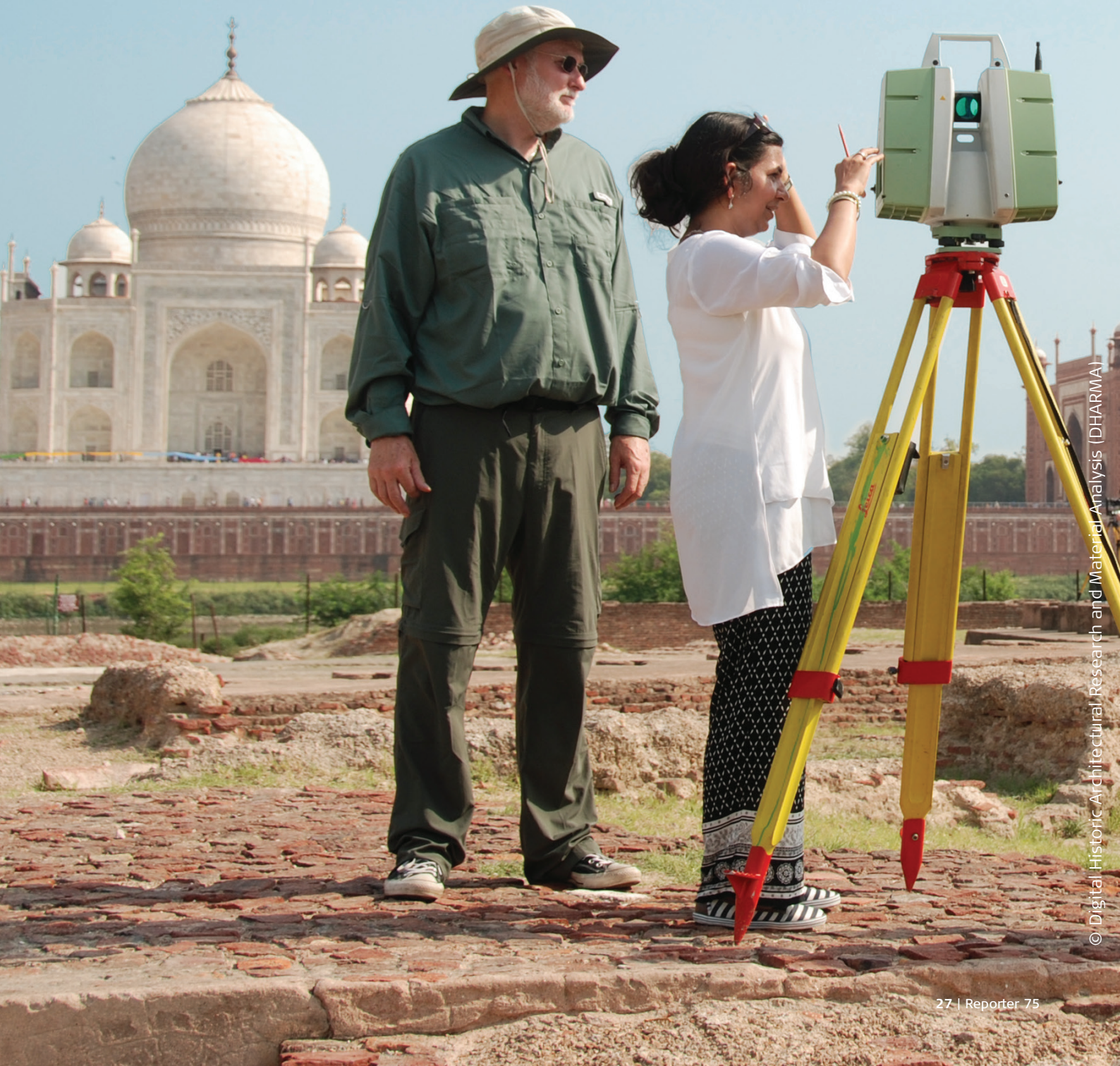
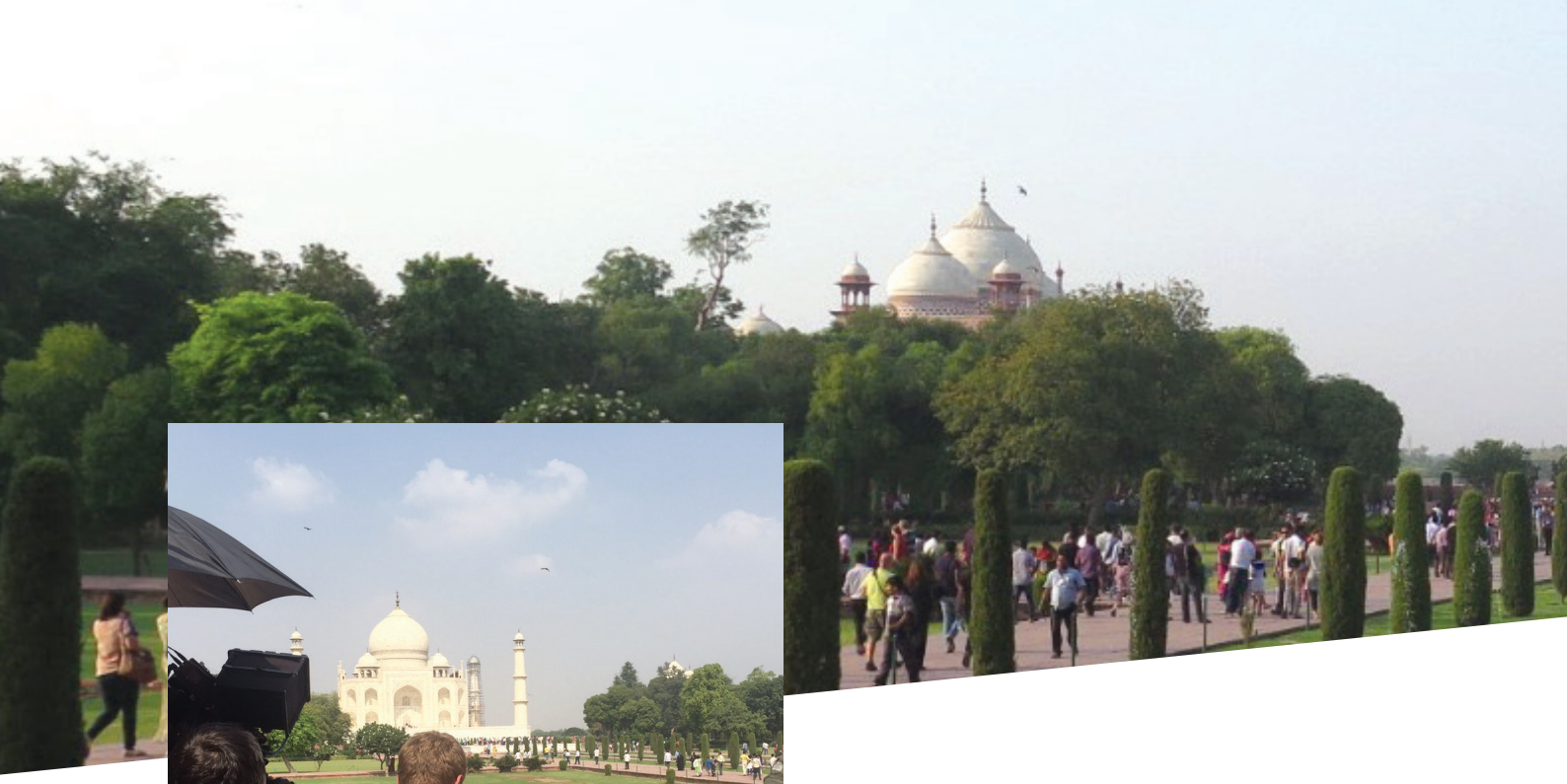
Written by Amit Kumar

DIGITISING THE MIGHTY TAJ MAHAL

The Taj Mahal, Arabic for crown of palaces, is an ivory-white marble mausoleum on the south bank of the Yamuna River in the Indian city of Agra. Commissioned in 1632 by the Mughal emperor, Shah Jahan (reigned 1628–1658), to house the tomb of his favorite wife, Mumtaz Mahal, the tomb is the centrepiece of a 42-acre complex. Included in the complex are a mosque, guest house and formal gardens, all bounded by crenellated wall.



© Digital Historic Architectural Research and Material Analysis (DHARMA)



© Digital Historic Architectural Research and Material Analysis (DHARMA)

Construction of the mausoleum was essentially completed in 1643, but work continued on other phases of the project for another 10 years. The Taj Mahal complex is believed to have been completed in its entirety in 1653 at a cost estimated at the time to be around 32 million rupees, a value nowadays around 52.8 billion rupees. The construction project employed some 20,000 artisans under the guidance of a board of architects led by the court architect to the emperor, Ustad Ahmad Lahauri.

PRESERVING A NATIONAL TREASURE

In April 2015, a 7.8-magnitude earthquake razed Nepal to the ground and devastated the lives of millions. Apart from affecting 8 million people, the natural disaster severely shook and destroyed the architectural treasures of Kathmandu Valley.

This devastating destruction worried archeologists worldwide. Just 500 miles south of Kathmandu rests one of India's UNESCO World Heritage sites - the Taj Mahal.

Observing the extent of the ravage and the magnitude of this earthquake, Professor Krupali Krusche, an architecture professor at the University of Notre Dame in the United States, decided to measure the injury the earthquake may have caused to the treasure, if any. This project would also forever digitally preserve the Taj Mahal should the unthinkable occur in the future.

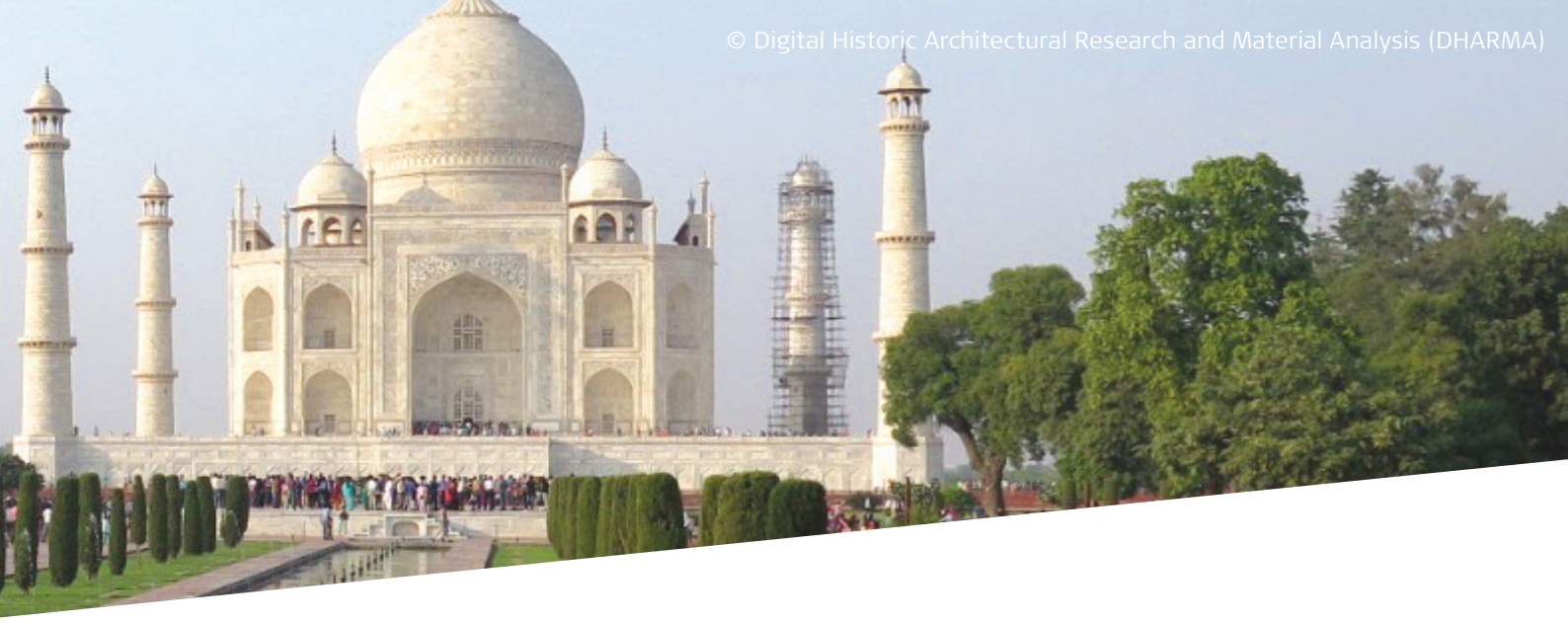
"3D blue prints allow us to understand how ancient structures were built and the techniques used to construct them," said Krusche. "So, in the event of a natural or man-made damage, they could be restored to their original state."

A SCANNING PARTNERSHIP

In October 2015, Krusche and a team of engineers and students travelled to India to document the Taj Mahal. Using the Leica ScanStation P20 and Cyclone software, they captured portions of the tomb up to 1 millimetre accuracy to obtain the spatial information necessary to analyse the state of the structural stability.

The team represented the Digital Historic Architectural Research and Material Analysis (DHARMA), an organisation committed to studying and preserving heritage sites around the world, such as the Taj Mahal. In partnership with the Archaelogical Society of India (ASI), the two organisations were able to discern, thankfully, no damage had occurred to the structure.

The ASI supervising archeologist on the project, Bhuvan Vikrama, was impressed with Leica Geosystems laser scanning technology.



"We collaborated with Dr. Krusche because she had the right mix of technology and expertise on the comprehensive digital mapping, which will be crucial for the future conservation and preservation of the Taj Mahal," he said.

SIMPLIFIED SCANNING FOR LEARNING

Another aspect for this project was the ability for student researchers to learn in a real-world environment. Capable of fast, accurate and highly-dense data collection, the ScanStation P20 is simple to operate, making it a great teaching resource.

Student research assistants Kristen Gates and Anthony Derouin have been involved in creating the stitched 3D scan data along with Gigapan images, enabling study of damage mapping. These images are then transferred on large scale models, allowing the students to study the large structure more thoroughly.

"The P20 was easy to operate, and we were able to create a textured 3D model quickly," said Gates. "Without the need to actually touch any artefacts, we felt easier about modelling the data and training in the Cyclone software."

The final information is being put together in the form of a joint report for ASI.