HERITAGE SCANNING

iPad & Tablet Ready!
DIGITALLY PRESERVING the Icons of Rani ki Vav
Seven hundred year old architectural treasure scanned in India

CyArk

Background to CyArk
CyArk is a 501(c)(3) nonprofit organization with the mission of “digitally preserving cultural heritage sites through collecting, archiving and providing open access to data created by laser scanning, digital modeling, and other state-of-the-art technologies.” In response to the Taliban’s destruction of the 1600 year old Bamiyan Buddhas in Afghanistan, and the increasing natural and human threats to heritage sites, CyArk was founded to ensure that heritage sites are available to future generations, while making them uniquely accessible today.

Digital Preservation is the 3D capture of cultural heritage sites, the creation of accurate 3D data sets, virtual tours, multimedia educational content, and deliverables for site conservators, and the free publication of this content on CyArk.org. In order to accelerate its mission and impact, CyArk has created the CyArk 500 Challenge—to digitally preserve 500 important heritage sites over 5 years.

CyArk was founded by Ben and Barbara Kacyra. Ben Kacyra is often referred to as the “Father of Laser Scanning.” After his commercial company was acquired in 2001 by Leica Geosystems, Mr. Kacyra founded CyArk to apply 3D capture technology to preserve our cultural heritage.

SCOTTISH TEN

Background to the Scottish Ten
The Scottish Ten is an ambitious five year project using cutting edge technology to create exceptionally accurate digital models of Scotland’s five UNESCO designated World Heritage
The team. Front (L to R): Rob Nuttal, Justin Barton, Lyn Wilson, James Hepher. Back (L to R): Alistair Rawlinson, Craig Logan. Taking the photo Mike Brooks.
The primary aims of the Scottish Ten project are to:

- Record important historical sites for the benefit of future generations in Scotland and overseas.
- Share and disseminate Scottish technical expertise and foster international collaboration.
- Provide digital media to site managers to better care for the heritage resource.
- Recognise international Scottish cultural connections.

Led by Historic Scotland—Scotland’s heritage agency—and its partner Glasgow School of Art, under their collaborative venture ‘The Centre for Digital Documentation and Visualisation LLP’, the Scottish Ten project will create digital documentation of the sites for future development of world class and innovative research, education and management. For more information, visit the project website: [http://www.scottishten.org](http://www.scottishten.org)

The 3D data from the Scottish Ten will be shared with our partner, CyArk in contribution to their ‘500 Challenge’ which seeks to digitally preserve the world’s heritage and disseminate the information publicly.

**The Digital Preservation of Rani Ki Vav for the Scottish Ten and CyArk 500**

In October 2010, a delegation from The Centre for Digital Documentation and Visualisation (CDDV) together with the Archaeological Survey of India (ASI) visited several heritage sites in Patan, Gujarat, India seeking the Scottish Ten’s second international site. Rani ki Vav, or the Queen’s Stepwell was one of those visited and the team were immediately awestruck by the scale, the beauty and the sculptural detail of the site. Built around 1050 A.D., it served as a communal water source for Patan’s royalty. Adorned with some 400 1-metre-high carved panels depicting Hindu deities and seven stepped terraces leading to the well itself, the site was only excavated in the 1960s and is wonderfully preserved at its lower levels. It is currently on UNESCO’s tentative list for World Heritage status.

The decision was easily made. Rani ki Vav fulfilled the Scottish Ten’s aims plus it provided the team with a challenge – with each project we endeavor to push the limits of the 3D technology. Rani ki Vav would prove to be a two-fold technical challenge. Firstly, in terms of capturing...
the exquisite Hindu sculptures at the required level of detail. Secondly, the logistics of how to capture the interior of the 7m diameter, 27m deep well, which was also decorated with incredible carvings. To meet the first of these challenges, we incorporated a new piece of scan technology in the form of a structured light scanner to record the sculptures at sub millimeter detail. In response to the second, we designed and constructed a custom aluminum and wood truss, onto which we could attach a scanner, extend it into the center of the well, and operate the scanner remotely via Wi-Fi.

After months of planning, the team arrived on site in India in mid October 2011. The six-strong CDDV team, led by Dr Lyn Wilson, had one day to acclimatize in Ahmedabad after the long journey from Scotland. Due to delayed flights, our CyArk colleague Justin Barton, landed after some 30 hours of travelling from California and had only 45 minutes to adjust to his new surroundings before meetings began!

CDDV and CyArk, collectively the Scottish Ten team, met with the ASI on the morning of October 17th in Ahmedabad. Our project fell under the jurisdiction of Dr Nauriyal, Superintending Archaeologist for the ASI Vadodara Circle and his team of surveyors and draftspersons. Over a delicious traditional lunch of naan, fresh Indian dishes, and some tea, the teams began to bond.

After lunch we piled into our van, heavily loaded with luggage and equipment and ventured north to Patan, about a three hour drive down roads swollen with cars, auto rickshaws, sacred cows, and camel-pulled carts.

We arrived at the Queen’s Stepwell just before sunset with enough time to review the site in the warm, late
afternoon glow. The site that we had studied in photographs, CAD drawings, 3D models, and documents was finally before us. Dug deep into the ground, terraced with pillared pavilions, and more beautiful and intricate than any photo or CAD drawing could convey, the site left us in awe as shadows streaked across and the sky turned orangey-red. Despite its beauty, this visit was practical and critical as the next morning work would begin. The purpose was to inspect the site in person, ensure our plan would work and determine any modifications as soon as possible to ensure success in our short window. Two weeks is not long when you’re surrounded by 400 statues of exquisite detail, representing deities with curled toes and beaded jewelry. After the site walk we realized that despite its complexity, we had the gear, we had the time, and we had the experience to accomplish the task. (After all, this team scanned a mountain in a forest just a year earlier).

Over the course of the next ten days, the Scottish Ten team worked to complete a comprehensive 3D digital survey of Rani ki Vav. Various technologies, each suited to a particular type of site documentation, were employed:

**Long-range 3D TLS**
The entire structure and surrounding terrain of the Queen's Step Well was digitally documented using a Leica C10 terrestrial laser scanner. Three traverses were completed around and inside the structure, working to an accuracy of 5mm.

**Mid-range 3D TLS**
Using a Leica HDS6100 laser scanner, the interior of the Step Well was documented at a higher resolution than captured by the C10. On-site daily registration of these scans achieved a mean absolute error of 1-2mm. For specific levels within the well itself, the scanner was cantilevered out using a custom aluminum truss with a wooden support rig. Specialist ropes work was carried out by Global Remote under guidance from CDDV. This allowed the team to scan areas and gain perspectives that were inaccessible with a conventional tripod setup.

**Close-range 3D Structured Light Scanning**
Using an Artec MHT scanner, high-resolution sub-mm scans of selected sculptures were collected, focusing on the most important Dashavatar panels as identified by the ASI.

**Digital Photography**
High-resolution digital photography occurred and High dynamic range (HDR) panoramic images were captured from all locations of mid (HDS6100) and long range (C10) scans to apply color information to the laser data. In addition, we collected texture photography for future meshes, ortho-rectified tilt-shift photography, and Gigapan 360° HDR imagery to generate Quick-Time VRs for virtual site tours.
We initially faced several technical difficulties during the documentation process. First, our equipment experienced overheating and hardware errors due to elevated operating temperatures in the heat of India. Scanners shut down and a few scans produced erroneous data. Our batteries over-heated and suffered failed states. Laptops and backup drives overheated and were regularly rendered inoperable in the late afternoon. We overcame these minor setbacks by keeping the scanners under heat-reflective umbrellas, ensuring spare batteries were stored out of direct sunlight and regularly allowed laptops and drives to cool in the afternoon for an hour or so.

To ensure our environmentally-related complications were not affecting our results, we checked the integrity of the scans on a daily basis as part of the data management and registration process. We were able to catch the few problematic scans and carried out repeat scans at cooler times of day to ensure we collected accurate data. Daily registration and backup occurred to ensure the site was both wholly mapped and the data was sound. Much of the data inspections, scan registrations, and multiple back-ups took place on-site during field work in the “command center”—a temporary structure of scaffolding and tarps, playfully nicknamed “The Eagle’s Nest” by the team. Justin Barton of CyArk oversaw data management, providing a role similar to the one he played at the Mount Rushmore National Memorial, USA project in 2010 (the first international Scottish Ten project). “The Nest” contained an abundant supply of extra batteries, pelican cases, memory cards, and the working laptops and backup drives; not to mention the steady supply of water and potato chips to keep us hydrated during the sweaty afternoons (the air conditioned car ride home was always a luxurious end to the day).

In all, approximately 175 scans were conducted with the two laser scanners; not including the literally thousands of photographs taken and submillimeter data capture of the Dashavatar panels. Raw, unprocessed data filled over 500GB of storage space and it was housed as multiple copies on 3 LaCie Rugged Hard Drives. The registration and management of so much information flooding in daily was, in itself, a monumental challenge. However as we saw the daily scan clouds come together, we saw the details of the Hindu icons materialize on screen.

We worked closely with our ASI colleagues daily, providing them with hands-on experience in 3D survey. We had many discussions on how to train ASI staff in data processing to help maximize the utility of the digital survey being conducted. And on the afternoon of October 24th, Lyn Wilson and Justin...
Barton traveled with Dr Nauriyal of ASI to Gandhinagar (Gujarat’s capital city) to meet with the Honorable Mr Fakirbhai Vaghela, Minister of Sports, Youth, and Cultural Activities. We discussed the details of the project, long-term collaboration desires, and the initiatives to bring digital preservation to India on a wide scale through the eventual creation of CyArk India.

The project received considerable media attention both in Scotland and India during the on-site data capture. And National Geographic sent out a photographer and a writer to cover the expedition for a future article.

**Next Steps**

Back in Scotland, work will now commence on further data processing and delivery of the 3D dataset to our friends at ASI in a useable format. This will further their conservation and survey work at Rani ki Vav. Deliverables will also be archived with CyArk and freely disseminated to the global public in the coming months. We hope the Scottish Ten involvement at Rani ki Vav will bring the site to a wider audience and bolster the case for UNESCO world heritage status of this wonderful site as well as lead to long-term collaboration in a nation of truly rich heritage.

For more information about the site and the project, the CDDV has produced a video. 

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**Lyn Wilson BSc MA PhD FSA Scot**

Lyn is Project Manager for The Scottish Ten and leads on digital documentation within Historic Scotland. Lyn is also Project Manager at the Centre for Digital Documentation and Visualisation LLP. She is a heritage scientist by training and her primary areas of interest lie in the scientific application of 3D reality capture within the historic environment and emerging technologies in heritage science.

**Justin Barton BA MA**

Justin is formally trained as an archaeologist with a BA from UC Berkeley and an MA from University College London where his graduate research focused on the use of 3D laser scanning to document earthen architecture to create better management tools, including information to monitor long term erosion. As Technical Services Manager at CyArk he oversees the development and evolution of standards and methodologies for data capture, processing, and archiving as well as the development of partnerships with universities, service providers, and government agencies. He has worked on over 30 CyArk projects world-wide.