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THROUGH VIRTUAL DOORS TO THE PAST

UQ architecture researchers are combining architectural history with digital reconstruction techniques to bring historic sites to life.

Imagine being able to walk around an historic site or building that is off-limits – whether because it's in ruins or is otherwise inaccessible – and being able to see how people really lived all those years ago.

Dr Kelly Greenop from the UQ School of Architecture has made this idea a reality, using digital technology to construct three-dimensional models of old buildings that make their actual form and function accessible to anyone with a computer or device.

This technology has several practical applications, and has already been used to develop cost-effective strategies for conserving accurate public records on several heritage-listed sites that have deteriorated over time. Partners such as Queensland Rail have also seen its benefit for projecting future solutions, such as a recent project that uses 3D-modelling technology to design footbridge upgrades that accommodated accessibility improvements.

Professor Greenop's analysis of historic sites has also revealed some interesting insights into the social standards of times they were built and used in.

"From our reconstruction of the Peel Island leper colony in Moreton Bay, we have been able to demonstrate how racism was literally 'inbuilt' through architecture," she says.

"For example, it's always been known that the island's lazaret featured clear segregation: white people were housed in furnished one-room accommodation within a fenced compound, while non-whites were housed in bark-roofed bush huts with earthen floors and cypress-clad walls. Our research captured those buildings, allowing people now to really see those differences."

By combining social and architectural history through digital reconstruction and preservation of old buildings, Dr Greenop and her team are opening avenues to teach and impart knowledge to future generations. A new discipline of data

collection and digital visualisation has taken the meaning of archiving history to the next level, digitally recording historic artefacts, places and culture to share and educate among a wider community.

"Digital cultural heritage gives us an opportunity to record sites really accurately and completely, which is hard to do using traditional surveying techniques, like going out with a measuring tape or laser measure," says Dr Greenop.

"People like it because you're capturing a version of the site that is very accurate and lifelike."

So how did Dr Greenop formulate this new 'window to our history'?

"Six years ago, I was working with some colleagues from the CSIRO who were developing the Zebedee laser scanner to assist robots with navigation and location sensing – a vital tool for emerging technologies such as driverless cars.

"The researchers were testing the scanner on buildings, and I immediately saw the application for cultural heritage. I thought it would be fantastic for architects because buildings are really hard to measure," she says.

"It takes a really long time, and you can sometimes miss a vital measurement in a complex building. If the buildings aren't perfectly orthogonal – if they have a lot of curves or natural materials – they're really hard to measure by hand. The use of laser scanning to measure solves all those problems."

To scan and capture the data needed to reconstruct 3D models, Dr Greenop and her team use a variety of tools, from the handheld Zeb1 mobile scanner to drone technology, as well as Leica tripod scanners for building interiors and exteriors.

"Using one of these scanners or a mobile scanner to capture what is called a 'point cloud' of a site – which represents millions of measurements taken with a laser scanner – those measurements are used to make a virtual reality version, a digital model, or a new interpretation of a heritage site," Dr Greenop says.

"With laser scanning you capture the whole site much more comprehensively and with a lot more detail than previously possible."

Dr Greenop and her team have so far scanned several sites of cultural significance, including the Fort Lytton military fortress and the former colonial prison at St Helena Island National Park. From the collection of point cloud data, textures and meshes have been generated to reconstruct the buildings and topographies of these sites, and the team have also gathered each site's architectural and social histories.

Upcoming projects include the digital preservation of heritage-listed sites within Brisbane, such as Queensland's notorious prison, Boggo Road Gaol at Dutton Park. A 3D model created by Jay Stocker – Dr Greenop's research assistant and a Master of Architecture student – allows an almost complete walkthrough of the entire prison complex.

Another is the Old Windmill on Wickham Terrace, Queensland's oldest surviving building, which was originally built in 1828 with convict labour. The School of Architecture has received $50,000 from philanthropist and UQ alumnus Huat Seng Lim to create a virtual reality version of the tower.

"We're developing a project in which people will be able to put on a pair of virtual reality goggles and walk up through the windmill tower, and hopefully also see it through some different time slices," Dr Greenop says.

"Its amazing history has been relatively inaccessible to date because the windmill has very steep stairs inside, so it's not really suitable to have lots of people going through."

Although a digital version of the windmill isn't available for public touring yet, Mr Stocker has drafted digitised versions of what the tower is like today and what it may have been in the 1840s.

"These virtual reality reconstructions will allow people to see current and past details of the building, right down to the historic graffiti on the walls and the machinery that the windmill used to contain," Dr Greenop says.

"We plan for this project to be made available to provide new ways for the public to be able to access heritage sites through digital interpretations."

Such significant projects allow people to traverse inaccessible historic sites, places and times, but will this 3D technology itself stand the test of time?

"To preserve digital records in an ever-changing technological environment where file types can become obsolete, we upload the digital models to CyArk, a database for global digital cultural heritage," Dr Greenop says.

"This website is designed to preserve at-risk heritage sites in perpetuity, by archiving and updating file types as technology changes."

"We have been fortunate to receive help to do this, from government groups such as the Queensland Parks and Wildlife Service, Queensland Department of Environment and Heritage Protection, and the Heritage Chairs and Officials of Australia and New Zealand, as well as from community groups like the Friends of Peel Island."

Dr Greenop and her team have been able to bring this technology of virtual reconstruction into developing 3D models of heritage-listed railway stations, such as Rosewood Station, in a collaboration with Queensland Rail and architectural firm Maytree Studios.

Queensland Rail Heritage Strategist Peter Osborne says that Dr Greenop's work has helped to improve Queensland Rail's efforts to preserve its historical assets.

"Dr Greenop's work has assisted in developing strategies to conserve our heritage structures, and has helped to create lasting records of structures that needed to be demolished due to safety risks," Mr Osborne says.

"In instances where heritage assets had to be demolished, Dr Greenop's 3D models were developed into detailed, dimensioned drawings as a public record. This was much more cost-effective than manually measuring and sketching the assets."

While these generated models of Queensland railway stations have preserved historical structures, they are also used to design future constructions from existing buildings or sites.

"These 3D models have been used to develop strategies around conserving heritage-listed timber footbridges at stations which have to be upgraded to accommodate accessibility improvements," Mr Osborne says.

"Maytree Studios used 3D modelling to test for the best solution to meet non-discriminatory access standards while minimising impacts on the bridges."

"Dr Greenop's work has helped to ensure that Queensland's Rail's history lives on well into the future, either standing in its original condition, or as a valued and accurate public record of the origins of our railways."

Architect Emily Juckes, an Associate with Maytree Studios, says that Dr Greenop's research provides an excellent base in developing an understanding of a site's existing conditions, which is the starting point for all heritage conservation work.

"The processes that Dr Greenop has developed feed directly into existing methodology used in architectural practice, and result in significant time and cost savings in the process to document the existing condition of sites," Ms Juckes says.

"The availability of quick, accurate modelling of sites that have access constraints – like an operational train station – is beneficial in conservation architecture, where the time and cost of recording and monitoring valuable heritage fabric is often significant."

"These 3D models have great value to us as the architect and to Queensland Rail as the owner of the heritage place, as the model becomes an excellent resource for monitoring, managing, and when required, altering heritage places."

Digital cultural heritage is a relatively new discipline and the emerging significance of this practice has found a developing community. Dr Greenop says she has been fortunate to work with her architecture students across the gap between technological and heritage experts.

"I've had a really close connection with the people who developed the technology, but there is often a bit of a divide between them and the people using the technology in the heritage world."

Dr Greenop and colleague Associate Professor Chris Landorf have started to bring researchers and industry together by organising conferences for the digitalcultural heritage: FUTURE VISIONS project.

"The digital cultural heritage sector does not have a strong international collaboration or set of standards yet," DrGreenop says.

"Internationally, we are bringing people together to see the state of the art in the emerging field of cultural digital heritage."

"We are helping shape a digital future for architectural history and theory, and architectural heritage management."

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Progress to date:

2012: First scanning trip to Peel Island with CSIRO to test the 'Zebedee' mobile laser scanner prototype prior to commercialisation. Peel Island is now scanned every year to study changes over time, and test new scanning technologies in a familiar, but challenging heritage environment.

2013: UQ scanning work is presented at a cultural heritage conference in Pisa, Italy, with collaborators from CSIRO.

2014: UQ Architecture purchases a 'Zeb1' scanner, the commercial version of the 'Zebedee' prototype, enabling independent projects using mobile laser-scanning technology.

2014: Dr Greenop begins electives within the School of Architecture to ensure Master of Architecture students can learn how to use 3D laser scanners, work with point-cloud data, and consider issues of heritage buildings and digitisation in their coursework.

2014: Fort Lytton heritage site is scanned by CSIRO and visualised by UQ Architecture students and staff, and is archived in the CyArk database. This is Australia's first CyArk inscription.

2014: UQ Architecture, CSIRO and Queensland Parks and Wildlife Service achieve a highly commended recognition in the Queensland Premier's Sustainable Heritage Awards for their project on Digital Cultural Heritage in Moreton Bay.

2014–present: Queensland heritage sites are scanned whenever possible, especially significant and at-risk sites including UQ's Great Court, The Commissariat Store, Spring Hill Baths, and more. Over time these sites are archived as open-access files on UQ eSpace for other researchers to investigate.

2014–present: Master of Architecture students work on electives that include scanning, interpreting and archiving cultural heritage sites in novel ways.

2015: UQ acquires Leica ScanStation high-resolution tripod scanner, enabling more capacity for scanning in particular settings, such as where detailed surfaces are needed or where colour point clouds are beneficial.

2015: UQ Architecture offers consultancy for scanning and digital modelings of buildings, for architects and institutions to use captured site measurements and develop accurate plans for changing or working with heritage buildings.

2016–present: Consultancy work with Queensland Rail to scan and visualise heritage stations ahead of modernisation and to fully preserve the record of heritage listed stations, such as Rosewood station.

2016: The Windmill Tower on Wickham Terrace is scanned and modelled to create a virtual reality model showing the windmill building now, and as it stood in the 1840s. Philanthropist Dr Huat Seng Lim provides funding for this project.

2017: The Peel Island project is featured on BBC Television's Click TV program, focusing on the collaboration between robotics engineers who assist with data capture of the heritage site through many technological means, including drones, wheeled robots and walking robots.

2017: UQ Architecture host the FUTURE VISIONS conference at the State Library of Queensland, with a follow-up symposium at University College London. Speakers from around the world present examples of new ways heritage sites and objects can be preserved digitally, managed and archived in news ways.

April 2018: UQ Architecture researchers Associate Professor Chris Landorf and Dr Kelly Greenop will feature at the Society of Architectural Historians conference at St Paul, Minnesota, with a panel on Digitising Architectural History.

September 2018: Associate Professor Landorf and Dr Greenop will lead a panel discussion on digital cultural heritage at the Association of Critical Heritage Studies conference in Guangzhou, China.