

Impact case study (REF3)

Institution: University of Bradford		
Unit of Assessment: C15 Archaeology		
Title of case study: Visualising Heritage: digital transformations in heritage and archaeology		
Period when the underpinning research was undertaken: 2011 - 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Prof Andrew Wilson (AW)	AW - Professor	AW - 2002 to present
Dr Adrian Evans (AE)	AE - Lecturer	AE - 2007 to present
Dr Jo Buckberry (JB)	JB - Reader	JB - 2004 to present
Dr Karina Croucher (KC)	KC - Senior Lecturer	KC - 2013 to present
Prof Chris Gaffney (CG)	CG - Professor	CG - 2007 to present
Prof Vince Gaffney (VG)	VG - Professor	VG - 2015 to present
Tom Sparrow (TS)	TS - Senior Scientist	TS - 2010 to present
Period when the claimed impact occurred: 1 Aug 2013 to 31 Dec 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact (indicative maximum 100 words)		
<p>The University of Bradford has established digital documentation as a mainstay for heritage research. Impacts are driven by world leading research in 3D scanning and visualisation and open data. In human bioarchaeology we have created a virtual resource and a drive for the ethical use of human remains data in education for applications in pathology and forensics. A corpus of work in the global museums sector has enhanced of public engagement through 3D scanning and virtual display. We have enhanced the lives of refugees and displaced societies through work with digital heritage and co-creation as a new and valuable toolkit for social cohesion and wellbeing.</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>Transformative research on digital imaging combined with image capture, processing, analysing and presentation of rich 3D datasets has led to impact in several key areas. In the area of human remains, the From Cemetery to Clinic/Digitised Diseases projects (Wilson with Buckberry, Gaffney C. assisted by Sparrow (2011-2013) (R1) used research into the use of high-fidelity methods for object capture to produce ground-breaking educational and research assets. The projects New Tools and Old Stones (Evans, 2012) and Visualising Hard Animal Tissues (Wilson, 2013-2014) followed, which expanded our research into the pioneering use of high-fidelity methods for object capture to support the digital curation and sharing of artefacts and scarce, protected resources. Further fundamental research and innovation in the AHRC Digital Transformations Theme Large Grant, Fragmented Heritage (Wilson and Evans, 2013-2019) explored the quality of digital capture methods (photography and 3D scanning), visualisation approaches and other outputs, including 3D printing for museum display (R3). The results brought about a revolution in micro and macro 3D visualisation methods (R2). This project included ground-breaking workflows using citizen science (e.g. Fossil Finders) and web-scraping/crowd-sourcing of imagery (Curious Travellers, Gaffney C. and V.). Recent investment from Research England World Class Laboratories fund for digital storage will sustain and secure the legacy of this open data.</p> <p>Further innovative developments of note explore citizen science approaches. Fossil Finder produced landmark and unsurpassed high resolution aerial imagery of fossil beds in Kenya [R4]</p>		

and was the first project that allowed the public to directly participate in the search for early human remains and palaeo-landscapes. UKRI strategic initiatives enabled us to target support towards ODA countries and global challenges, Augmenting Jordanian Heritage (Led by Wilson and Evans [2016-19]) was developed to transfer knowledge from within the Fragmented Heritage project and build capacity in the heritage and tourism sector in Jordan. This supported the creation of an asset bank of valuable Jordanian artefacts and sites, explored the use of virtual-reality and augmented museum display for dissemination, provided high-level training in the use of digital heritage techniques and approaches, and has left a legacy of capacity with the Jordan Museum to build digital heritage capacity in the region. Curious-Travellers advanced the use of crowd-sourced and web-scraped imagery to reconstruct 3D models of heritage that had been damaged or destroyed. It co-produced new cultural resources of UNESCO World Heritage sites including Palmyra, Syria; in Kathmandu, Nepal, this was used to inform rebuilding post-earthquake [R5] (co-investigator Wilson, research assisted by Sparrow [2018-19]). Knowledge and practice that underpins the Curious Travellers approach was repurposed within the BRaThe project (Led by Evans with Croucher, Wilson [2019-21]). There, digital heritage has been used as a tool to promote social cohesion and individual wellbeing with a view to increasing personal security in displaced communities. This included working with refugees based in camps through Humanitarian organisation Mercy Corps and integrating communities within the local township [R6].

3. References to the research (indicative maximum of six references)

R1 Wilson, A.S. et al. (2017) Digitised Diseases: Seeing Beyond the Specimen to Understand Disease and Disability in the Past, in *New Developments in the Bioarchaeology of Care*
https://doi.org/10.1007/978-3-319-39901-0_16

R2 Evans, A.A. et al. (2014). Standardization, calibration and innovation: a special issue on lithic microwear method. *Journal of Archaeological Science*, 48, 1–4.
<https://doi.org/10.1016/j.jas.2014.03.002>

R3 Büster L.S. et al. (2016) Developing the 3D imaging of Iron Age art in the ENTRANS Project. In: Armit I, et al (Eds.) *Cultural Encounters in Iron Age Europe*. Budapest: Archaeolingua: 23-38.

R4 Evans, A.A., et al. (2017). Transforming the search for human origins using new digital technologies, low altitude imaging, and citizen science. In Gaffney et al. *12th International Conference of Archaeological Prospection*. Archaeopress.

R5 Wilson, A.S. et al. (2019). Curious Travellers: Repurposing imagery to manage and interpret threatened monuments, sites and landscapes in Dawson, M., et al. (Eds) *Heritage Under Pressure, Threats and Solutions: Studies of Agency and Soft Power in the Historic Environment*, Oxford: Oxbow Books, pp107-122 <http://dx.doi.org/10.2307/j.ctvpmw4hr.13>

R6 Evans, A.A. et al. (2020). Virtual Heritage for Resilience Building. Published project summary poster. <https://doi.org/10.5281/zenodo.3950360>

Grants

- Evans et al, Building Resilience Wellbeing and Cohesion in Displaced Societies Using Digital Heritage, AH/S005951/1, AHRC, 2019-2021, GBP84,297
- Coningham et al, Seismic Safety and Kathmandu's Historic Urban Infrastructure, CI170241, British Academy GCRF, 2017-19, GBP299,992
- Johnson et al. 'Project code-named Humpty': Creation, Destruction and Reconstruction. An art and archaeological science collaboration. AH/R004846/1, AHRC, 2017-21, GBP79,888
- Wilson et al. Augmenting Jordanian Heritage. AH/P00945X/1, AHRC, 2016-2019, GBP205,954

Impact case study (REF3)

- Wilson et al, Fragmented Heritage (incl Curious Travellers), AH/L00688X/1, AHRC, 2013-2019, GBP1,854,691
- Evans, New Tools and Old Stones: The Use of 3D Microscopy on Stone Tools to Understand Prehistoric Behaviour and Social Change, AH/J007935/1, AHRC, 2012-2013, GBP63,366
- Wilson et al. Visualising Animal Hard Tissues, AH/K006169/1, AHRC, 2013-2014, GBP78,009
- Wilson et al. From Cemetery to Clinic, Jisc Content Programme 2011-2013, Rapid Digitisation Scheme, 2011-11, GBP116,499
- Wilson et al, Digitised Diseases, Jisc Content Programme 2011-2013, Mass Digitisation Scheme, 2011-13, GBP937,458
- Wilson et al., Research England WCL, 2020-21, GBP160,000

Awards and Recognition

[Highly Commended Finalist for Association of Learning Technologists Research Award for Shetland in the Iron Age: Interactive iBook](#)

4. Details of the impact (indicative maximum 750 words)**Human Bioarchaeology – virtual surrogates**

Digitised Diseases has been at the forefront of a global uptake of open-data in developing open-access 3D resources for human bioarchaeology. Our approach addressed the threat of pressure on osteological collections, highlighting the role of 3D capture as a conservation record for fragile pathological bone specimens. The resource addressed training needs in biological anthropology, history of medicine and for clinicians concerned with chronic conditions, neglected diseases and re-emerging conditions, with greatest uptake in N. America where constraints with human remains collections has encouraged significant use. The resource has been accessed more than 3,437,887 times globally. The resource has been used in institutions for osteological teaching and individual learning throughout the world, with metrics for 2020 showing that usage of the resource in North America is now more than 5.7 times that of the UK, highlighting the need for virtual material work with in places that have limited access to collections of human remains [C1]. The project has changed perceptions and approaches, informing and cited in the development of a BABAO imaging code and as co-signatory to Kyoto WAC resolution on ethical use of digital human bioarchaeology data. Increased usage throughout the periods of regional and national lockdowns imposed during 2020-21 due to COVID-19 illustrate the value of this virtual resource when physical collections are inaccessible (monthly website traffic reached a peak >4 times more than normal during lockdown) [C1].

Public Engagement through virtual and physical surrogates

The Visualising Heritage group has tested through multiple avenues of engagement, the capability for enhanced visitor experience and understanding of cultural heritage, in using 3D printing of cultural objects. Multiple examples exist including the Stonehenge Visitor Centre exhibition which reopened December 2013. Historic England funded research undertaking 3D scans to create 3D prints of Neolithic cranium from Winterbourne Stoke Long Barrow to provide facial reconstruction giving visitors the chance to “meet” a Neolithic individual. Around 58,000 copies of the guidebook purchased each year and >9 million visitors have viewed this since the visitor centre opened personalising their experience of this world-renowned ritual landscape [C2]. In Slovenia, as part of the ENTRANS project, the group exhibited replicas of enlarged sections of bronze age objects increasing access to these national cultural treasures and contributed to improved public understanding of ancient manufacturing techniques, usually only seen under a microscope. The group also contributed to the Ice Age in Europe exhibition (2015-2017) by producing a replica of the Happisburgh beach where footprints dating to around 1 million years were discovered (and since lost) following a storm. Visitors could stand on this to allow them to understand variations in deep human lineages (‘Ice Age Island’ Exhibit was mentioned in Jersey Heritage Trust annual report as contributing to a 3.5% increase in visitors to Jersey); the exhibit itself had 65,000 visitors [C3].

Co-creation of knowledge through Citizen Science and Inclusion

Fossil Finder transformed traditional methods of field survey in remote locations and was launched at the British Science Festival (2015), providing a web portal to the public and inviting all interested to take part in the search for human fossil remains. This generated over 12,000 visits per month, creating a landmark change in accessibility to such activities, widening participation to allow disabled people and individuals from financially underprivileged backgrounds to take part in exploration. It attracted over 8000 registered contributors from 98% of countries, and many more casual users who found and labelled new fossil finds in over 120,000 images [C4], and it created a new understanding of fossil density in the Turkana Basin.

Curious Travellers involved the public in efforts to record cultural heritage that had been damaged or destroyed. Methods developed through the Curious Travellers project enable 3D visualisation of heritage lost or damaged by neglect, cultural vandalism, conflict and natural disasters. The repurposing of crowd-sourced and web-scraped imagery has been used to rebuild 3D models of structures, including the Temple of Bel at the UNESCO World Heritage Site of Palmyra in Syria, previously destroyed by ISIS (utilising 109,269 images, equivalent to 205GB data) [C5]. This workflow was also used to enhance understanding of architectural practice, design and planning, as with post-disaster reconstruction and resilience work in the aftermath of the 7.8Mw magnitude earthquake that destroyed temples and religious complexes in the UNESCO World Heritage Sites of Kathmandu, Nepal. Detailed 3D models were built through web-scraping/crowd-sourcing (303,000 images were sourced, of which 50,000 were sampled and filtered, with 25,000 images matched). Point clouds for the Durbar and temple squares are ~350 million points in total and where possible these have been processed to produce meshed and textured models. The resultant images, database files and processed 3D models (~2.8TB), together with mobile mapping data have directly contributed to understanding and workflows used by conservation architects to inform the rebuilding of the World Heritage Site [C6].

Empowerment through Capacity Building and Knowledge Transfer & Changing Lives in Lower and Middle Income Societies

Augmenting Jordanian Heritage provided in-country training and workshops as part of overseas development aid which have produced enhanced 3D display of artefacts within Jordanian National Museum; ongoing work in empowering key individuals in heritage governance within Jordan by digital upskilling for increased reliance on digital exhibits and information [C7]. The BRaThe project has successfully utilised digital heritage engagement to improve the quality of life of displaced individuals and communities [C8]. The project developed multiple assets, utilised those from the group's catalogue of projects, including Curious Travellers, plus further citizen-donated datasets into VR-ready content. These were co-created in dialogue with displaced refugee communities from Syria, working with the international aid agency Mercy Corps at Azraq camp and with Jordan Heritage in Azraq township. Used outside enclosed refugee camps, the work has transformed the ability for the effective leadership of a community [C9] and caused a change in social structure that has significantly improved the quality of life within the refugee camps [C10].

5. Sources to corroborate the impact (indicative maximum of 10 references)

C1 Email/ Letters giving testimonial from Past-President of Palaeopathology Association and Editor of Gray's Anatomy/ Trustee of the Hunterian Collection/ Head of Museum Collections, Royal College of Surgeons which emphasise the importance of Digitised Diseases as a learning resource that transcends disciplines, has international reach and which saw increased hits whilst access to physical collections has been restricted due to Museum closure and COVID; Digitised diseases is cited several times in the BABAO digital imaging code as an exemplar to practitioners [BABAO-Digital-imaging-code-2019.pdf](#)

C2 Letter from Senior Properties Historian at Stonehenge (Historic England) - with metrics on footfall figures (with more than 9 million visitors since the Visitor Centre opened in December 2013), guidebook purchases featuring the reconstruction (~58,000 copies per year) and evidencing how understanding was changed through visitors engaging with this exhibit which is

'one of the most popular and memorable parts of the permanent exhibition and brings people face-to-face with a person who lived in this landscape 5,500 years ago'.

C3 [Annual report from Jersey Heritage](#) on tourism to the Island showing 187,910 visitors in 2016 and 65,000 visitors to the Ice Age Island Exhibition along with 5000 school children visits. Pages 14, 40.

C4 Public 'citizen scientist researchers' chat discussions forum illustrates the rich nature and public engagement with the research: <https://www.zooniverse.org/projects/adrianevans/fossil-finder/talk>

C5 UK Government Ministerial quotes: *'Destruction of the world's monuments is a deliberate attempt to undermine a community's cultural identity...thanks to [Bradford's Fragmented Heritage/Curious Travellers/BReaTHe research], our holiday pictures could now help rebuild and preserve these ancient sites for future generations.'* Universities Minister [2016 – quote via BEIS featured in press release for British Festival of Science and was reproduced in News coverage]... *'[The VR is] startlingly real...to allow people in Syria and Jordan to see these great sites and historical items which they have not otherwise access to, or have been destroyed...it must be a great comfort'* Secretary of State for Scotland [2019 – Royal Highland Show, 21 Jun visit to UK Govnt Showcase Tent].
https://twitter.com/mercycorps_uk/status/1141656726741180422

C6 Testimonial letter from Conservation Architects/ UNESCO Consultant responsible for coordinating culture sector response and helped establish the Earthquake Response Coordination Office (ERCO) at the Department of Archaeology – Highlight the impact of Curious Travellers datasets as part of British Academy GCRF Cities & Infrastructures research, informing reconstruction efforts in Kathmandu, Nepal.

C7 Director of Science and Technology, The Jordan Museum (JM), Statement of project success and legacy. "...The project successfully managed to scan the some of the most important objects among the collection of the JM; these scanned copies were used in the documentation system of the JM. The JM integrated these scans within the physical exhibitions by displaying it next to some of the most popular objects (like the Dead Sea Scrolls, Ain Ghazal statues, the Altar from Pella, etc). These scans were an eye-catching spots in the exhibitions which enabled visitors to "digitally touch" the objects..."

C8 Director of Programs, Mercy Corps Jordan, Letter of support "...*this explorative work has provided a strong, industry leading, focus on the use of technology within displaced communities for well-being. For us, this collaborative project aligns very well with Mercy Corps' mission and programmes in Jordan, and in the wider region....*". Also see:
<https://twitter.com/AdrianEvans/status/1185139302650523648>

C9 Quote from the Mayor of Azraq Township Jordan – translated from township meeting, recorded 17th February 2020 "the [BReaTHe] project has very clearly united previously disparate culturally varied pockets of populous in the town" "it has helped greatly in the coordination of administrative efforts to improve community spirit".

C10 Quotes from refugees at Azraq Camp, Jordan – include "my daughter was little when she left Syria, since the VR she has started remembering and talking about Syria, I had no idea she could remember so much", "We considered Azraq Refugee camp as a prison and living in the fenced area of Village 5 is like living in a prison inside a prison. We can't go outside to see the world, but through the VR, you brought the world to us." - see
<https://doi.org/10.5281/zenodo.3950360>