5.1   Impact case study (REF3)

Institution: Falmouth University		
Unit of Assessment: 32		
Title of case study: Enabling Cornish Museums to offer Immersive Visitor Experiences		
Period when the underpinning research was undertaken: 2016-2020		
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. Tanya Krzywinska	Professor	2013-present
Dr. Michael Scott	Course Leader	2015-present
Al Parker	Senior Lecturer	2010-present
Tim Phillips	Research Fellow	2018-present
Period when the claimed impact occurred: 2018-2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact

Our research has enabled 8 Cornish museums and heritage providers to offer their visitors exciting virtual reality and augmented, game-based, experiences that are tailored around their collections and environments. These are: Porthcurno Telegraph Museum, Bude Heritage Centre, Isles of Scilly Museum, St Agnes Museum, Looe Museum, Goonhilly Earth Station, The Eden Project & Golden Tree. In addition, further beneficiaries are Cornwall Museums Partnership, a charity designed to support regional museums and the Cornwall Local Enterprise Partnership (LEP). Based on our work immersive design has been identified as an area for growth and investment in Cornwall both by the LEP in the Local Industrial Strategy and Cornwall Council in the Creative Manifesto. Through our practice-based immersive experience design and development research, delivered through collaborative co-design, workshops and design blueprints, our beneficiaries' have learned new marketing, data gathering and digital skills. Our research has therefore permitted these cultural providers to offer their visitors the types of bespoke technologically enhanced immersive experiences that would otherwise only be available in large London-based museums such as the Science Museum.

2. Underpinning research

Museums face challenges in engaging diverse audiences; many visitors report being underwhelmed by traditional museum and heritage spaces. This is perhaps not surprising given that contemporary media routinely uses special effects to bring history to life. With the recent availability of immersive technologies (virtual and augmented reality headsets), it was possible to bring games technologies and design to heritage contexts at a relatively low cost. However, a set of blueprints was badly needed to help small development teams to co-design and deliver applications in collaboration with individual museums and curators. To address this need, we developed bespoke immersive installations for 8 Cornish museums and heritage providers [3.1;3.2;3.3;3.4]. The research was conducted between 2016 and 2020 by Prof. Tanya Krzywinska (2013-present), Dr. Michael Scott (2015-present), Alcywn Parker (2010-present) and Tim Phillips (2018-present).

Developing immersive experience design for Museums

Principally, our research explored uses of new technologies to bring history and heritage to life for audiences of a specific heritage provider. Co-design and collaboration with our partners guided our method, through workshops and a user-centred approach. This produced a workflow model based on our evaluation of using different methods of co-design [3.1]. We encountered and solved a wide range of design and technical problems that produced knowledge of value to immersive developers and museum curators. We found

effective ways of overcoming implementation issues (including COVID); solved problems with the design of interfaces that have proved a barrier to public use; developed effective game-based methods of interpreting elements of museums' collections or locations that combine education and entertainment to reach new audiences and improved the 'digital' literacy of our partners in response to market needs [3.1; 3.2]. It emerged from our research that there was a strong need for effective co-design methods to help our partners to offer inclusive and meaningful immersive experiences.

Combining real world objects and virtual interfaces

Previously augmented reality (AR) and virtual reality (VR) used in heritage locations have been limited to text-based overlays viewed on a phone. Our research has shown that we can engage visitors in richer and more imaginative ways. One of our major achievements was the development of haptic interfaces to help bypass complex unintuitive AR controls; we also needed to make such interfaces relevant to a specific heritage context. We have designed experiments to test this with users [3.2]. Not only has haptic design created a solution for a pernicious technical problem that limited user access, it had also led to a more engaging, tactile, and intuitive experience for museum visitors [3.2]. In bringing real objects into the immersive experience, we have also enabled visitors to engage with museums' collections in a more direct and immediate way, giving those haptic objects greater contextual and historical meaning.

In developing public-facing products, we collected and analysed user data from our prototypes [3.4; 3.5]. Throughout this research we developed novel immersive and game-based technologies experiences designed to interpret a collection or place and to give visitors a more tangible and situated experience of historical moments and events, whether as an 'augmented' telegrapher at work during WW2, a 19th century sea captain navigating Bude's coastline, or, as a medieval monk living on Looe Island.

3. References to the research

3.1 Krzywinska,T., Phillips, T., Parker, A., & J Scott, M. J. (2020) From Immersion's Bleeding Edge to the Augmented Telegrapher: A Method for Creating Mixed Reality Games for Museum and Heritage Contexts. *Journal on Computing and Cultural Heritage*. December 2020.[Journal article] https://doi.org/10.1145/3414832
Listed in REF2 (Output Identifier: 469)

3.2 Scott, M.J., Parker, A., Powley, E., Saunders, R., Lee, J., Herring, P., Brown, D., & Krzywinska, T. (2018) Towards an Interaction Blueprint for Mixed Reality Experiences in GLAM Spaces: The Augmented Telegrapher at Porthcurno Museum. Proceedings of the *32nd BCS Human Computer Interaction Conference*, 2-6 July, 2018, Belfast, NI. [Conference contribution] https://doi.org/10.14236/ewic/HCI2018.135

3.3 Lelièvre, E., Rubino, G., Summerley, R., & Phillips, T. (2020) Virtual gardening: Identifying problems and potential directions for 'ecological awareness' through soil management and plant recognition gaming. *Journal of Environmental Media*, 1 (2). pp. 185-207.
https://www.ingentaconnect.com/content/intellect/jem/2020/00000001/00000002/art00006
 [Journal article] Listed in REF2 (output identifier: 170)

3.4 Parker, A., & Scott, M. (2018) Crafting Engaging Programming Experiences for Young People in GLAM Spaces: The iOi-Sphere. ITiCSE 2018, July 02 - 04, 2018 [Conference contribution]. https://doi.org/10.1145/3197091.3205827

3.5 Krzywinska, T. (2016) Formations of Player Agency and Gender in Gothic Games. In *The Edinburgh Companion to Women in the Gothic*. eds. Avril Horner et al Edinburgh University Press, 2016. https://doi.org/10.3366/edinburgh/9780748699124.003.0015 Listed in REF2 [output identifier: 40]

Outputs 3.1-3.4 have each been subject to rigorous peer review; while 3.5 has undergone peer review prior to being accepted by editors and publishers.

Research Grants led by team members directly supporting the impact outlined in this case study.
G1. EC. FP7. 'Games Research Opportunities' CO-I/Lead/CO-I: Krzywinska. EUR 2,938,487. 01/03/14-30/04/2019.
G2. AHRC. 'The Augmented Telegrapher'. AH/R009406/1. Lead: Krzywinska £70,714. 01/12/2017-31/08/2018.
G3. Research England. Connecting Capabilities Fund.' South West Creative Technology Network'. CCF13-7164 Co-I: Krzywinska. £4,585,416.00. 01/04/2018-31/03/2021.
G4. AHRC. Follow-on Telegrapher. AH/S01053X/1. Lead: Krzywinska. £39,017.
G5. Coastal Communities Fund. wAVE. CCFR5078 Lead: Krzywinska £768,596. 01/04/2019-31/03/2021.
G6. Innovate UK: Space on Earth. 19131. Co-I: Scott, M. £55,676. 01/10/2018-31/03/2019.
G7. Arts Council England. Kerdroya. Lead. Krzywinska. Co-I: Parker, A.£95,472. 01/04/2020-31/03/2021.
G8. ERDF. Immersive Business. Lead: Krzywinska. Co-I: Brown,M. £2,047,004.

4. Details of the impact

Our research has enabled Cornwall's heritage sector to make their offer more relevant to contemporary expectations. Our partners are now able to reach out to under-engaged, hard to reach, elements of their audiences and are more resilient for a future that might look very different, post pandemic. The main beneficiaries are: **Cornwall Museum Partnership [CMP]** (2017-present), **Porthcurno Telegraph Museum [PTM]** (2017-present), **Eden Project** (2018), **Goonhilly Earth Station** (2018), **Bude Heritage Centre** (2019-2020), **St. Agnes Museum** (2020), **Looe Museum** (2020), **Isles of Scilly Museum** (2020), **Golden Tree** (2020) & the **Local Enterprise Partnership** (2019-2020).

Impact on Cornwall Museum Partnership (CMP)

Since 2017, we have enabled CMP to support their 60 client museums in the uses of immersive technologies as means of helping protect those museums and their collections for future generations [5.1]. In terms of support in strategic direction for CMP, Krzywinska provided expertise on new and upcoming immersive technologies in museums contexts including for a new collections archive. Our research has enabled CMP to add a new dimension to their ability to advise and support their client museums, thereby helping to retain and create jobs for the region. As reported by the CEO of CMP, our research has led to the creation of "*13 jobs*" and allowed CMP to have "*supported and trained over 600 people from across the heritage and tourism sectors. This directly contributes to the economic strategy of the region*". [5.1]. The CEO of CMP also reports that "*the immersive research team at Falmouth really understand and support our objectives and have been quick to anticipate and respond to the specific industry needs of the heritage partners with whom we work; their research has enabled us to take our museum clients into new market opportunities*" [5.1].

Impact outside the Region

We have staged demonstrations of immersive designs at CMP events and have given 5 immersive skills-building workshops to local museum staff. 7 immersive introductory sessions have been given: 2019/20 'build a chat bot' (30 attended); 3D Tours (7 attended); Immersive Marketing (8 attended); Realtime World in VR (12 attended); Inclusive Immersive (14 attended). Delegates at these events came from across the UK (Dunbar, Edgeware, Milton Keynes) and beyond (Harare, Calgary, Sydney and Melbourne) as well as from the South West [5.9.4]. Delegates also came from industries outside heritage, including marketing, construction, research and tourism [5.9.4]. Based on our collaboration and

expertise, CMP have been able to set up a UK-based Immersive Network centre for all UK museums, inaugurated by an online workshop (24/6/20) attended by 90 museum staff and curators from across the UK, and at which Krzywinska was an invited speaker.

Impact on Museums

Our immersive, game-based design and technology for heritage contexts research has had a direct impact on the market reach of 8 museums and heritage sites in the region.

Porthcurno Telegraph Museum [PTM] has substantially benefited from our research in two different ways. Working closely with PTM and CMP, and funded by the AHRC, we have developed an historical 'Escape Room' experience using the HoloLens, entitled 'The Augmented Telegrapher', designed for group use on location in the museum's tunnels (built in WW2 to protect vital cross-Atlantic communications equipment). Players work together to solve puzzles using various haptic devices that communicate player actions to a headset computer [5.8]. The installation allowed the museum to enter the 'Escape Room' market [5.3; 3.1; 3.2]. Postponed due to COVID, the experience is due to be launched at their postponed 150-year celebration Spring 2021. PTM has also benefited from the app we made to entice beach-going holidaymakers into the museum, its shop and cafe. PTM's curator writes, "*The relationship we have formed with the Games Academy has been rewarding, not only in terms of the knowledge which your team brings to the table, but also in terms of their willingness to work collaboratively and supportively, responding positively to our (sometimes crazy) ideas and coaching us through the process of moving from idea, through to development, design and delivery*" [5.3].

Similar experiences have been developed for the other museums, including a VR experience co-designed with **Bude Heritage Centre** that also used haptics; using a real ship's wheel, visitors navigate a nineteenth century ship from the sea into Bude's canal in VR. User testing with 30 subjects produced comments such as '*Brought history to life*', '*It was fun and made your think how difficult it must have been*' and '*Delight to see the coast from a new perspective*' [5.9.1].

Another VR experience was also designed for visitors to **St. Agnes Museum**, a volunteer run museum, where they can experience seeing in 360 degrees a simulation to the harbour before it fell into the sea. The Museum Trustee's Chair has said that the impact of the research for that museum has been to, "*Attract new visitors and appealing to a customer segment (age 14-30) who we traditionally lose touch with...improving our standing in the museum sector and in the eyes of a new target group in our local community.*" [5.2] and our research has introduced the museum to "*cutting edge technology and provides us with a new tool that has undoubtedly already shifted our perspective and holds great promise for the future*" [5.2].

We also developed an app for **Looe Museum**, another app, co-designed with **Golden Tree** for a Cornish hedge labyrinth located on Bodmin Moor [5.5], a walking tour app for the **Isles of Scilly Museum**, an AR mobile game on plant care, entitled Tevi, designed for children for **Eden Project's** visitor centre [3.3] and a VR feasibility model of a physical visitor centre experience at **Goonhilly Earth Station** [5.6]. Each of these were designed to reach out to under-served audiences.

We had hoped and planned for public rollout of our immersive experiences in early Summer 2020. The restrictions caused by the pandemic made this impossible: museums were shut (some smaller ones remained shut over the summer), employees furloughed, and those that did open, decided it was best to postpone launch while social distancing was in place. All our installations and apps will now be launched at a festival event in Spring 2021.Therefore, we have not been able to collect data showing the intended increase in numbers of visitors, the increased levels of engagement or the economic impact on the surrounding businesses as we had intended. We do have other evidence of impact on museums and their audience,

based on their increased capacity to reach out to non-traditional audiences and on their knowledge and skills base.

Impact on regional businesses and Cornwall's Local Enterprise Partnership Strategy

Our innovation-lead research has allowed small Cornish museums to include the types of experiences that visitors might expect to see in well-funded city-based museums. Since 2017, we have given 15 talks and workshops based on our research to help build digital skills around the use of immersive in heritage and museum contexts. These include an event organised by Porthmeor Art Studios (provider of heritage/arts-based holidays in St Ives) (18/5/19) to demonstrate our immersive research to artists in the region (verbal feedback included the comment *"I had no idea VR and AR were so interesting!"*)'; a keynote and demonstration of our research at the Isles of Scilly symposium (7-10/05/19) attended by local tourist and arts providers; a talk and demonstration of our research to South West Creative Technology Network immersive industry and academic fellows at the Watershed in Bristol (2/11/18). Based on our research, Krzywinska was invited as immersive technology advisor and member of the South West Arts reference group set up to advise the Arts Council (2019-2020) on digital art in the region.

Our research has also led to the inclusion of immersive design in the LEP's Local Industrial Strategy published in early 2020 and to Cornwall Council's Creative Manifesto (Nov 2020) that stated,*" We will work in partnership with the Cornwall and Isles of Scilly Digital Skills Hub along with advocating for ground-breaking projects such as Cornwall Museums Partnership's wAVE project – focused on developing immersive tech experiences with museums to engage with their audiences and communities. This, in turn will strengthen their local visitor economies, and introduce other businesses to the potential of immersive tech for growth: **a pioneering example of how tech in museums can enable positive social change."* Based on our work immersive design has been identified as an area for growth and investment in Cornwall. Building on our research as a means of growing immersive business in the region, we have partnered with Exeter University in a successful European Structural and Investment Funds Growth Programme Priority Axis 3: Enhancing the Competitiveness of Small and Medium Sized Enterprise bid (Awarded in April 2020) to apply our research expertise to retail, construction/architecture, events and tourism in Cornwall and the Isles of Scilly [5.4; 5.7; 5.10].

5. Sources to corroborate the impact

5.1 Letter from Director of Cornwall Museum Partnership.
5.2 Letter from Chairman of St Agnes Museum Trust.
5.3 Email from Director Porthcurno Telegraph Museum.
5.4 Letter from CEO, Cornwall and Isles of Scilly Local Enterprise Partnership.
5.5 Email from Director, Golden Tree Productions.
5.6 Letter from Senior Business Development Manager, Goonhilly Earth Station.
5.7 Local Enterprise Partnership Industrial Strategy reportage.
https://www.cioslep.com/projects/wave-project
5.8 Reuters news report based on our research for Porthcurno Telegraph Museum.
https://reuters.screenocean.com/record/1418595
5.9 User Testing data & workshop delegate data
     5.9.1 Bude Public Testing Data
     5.9.2 St Agnes College Focus group
     5.9.3 Augmented Telegraph Testing data
     5.9.4 CMP/Falmouth Immersive workshops delegate data
5.10 Cornwall's Creative Manifesto 2021-2025, p17 https://www.cornwall.gov.uk/leisure-and-culture/culture-and-creative-economy/creative-manifesto-2021-2025/