



University
of Glasgow

THE SCOTTISH HERITAGE PARTNERSHIP: IMMERSIVE EXPERIENCES

POLICY REPORT



NATIONAL
TRUST for
SCOTLAND



glasgow
museums



National Library
of Scotland

Leabharlann Nàiseanta
na h-Alba

soluis



Arts & Humanities
Research Council

EPSRC

Engineering and Physical Sciences
Research Council

CONTENTS

Executive summary	5
1. Project background.....	9
2. Project partners.....	10
3. Project context	12
4. Methodology	19
5. Our research findings and analysis.....	24
6. Questions for heritage providers	27
7. Risks.....	29
8. Conclusions and recommendations	30

THE SCOTTISH HERITAGE PARTNERSHIP: IMMERSIVE EXPERIENCES

POLICY REPORT

By Murray Pittock

*with contributions from Agiatis Benardou, Maria Economou,
Lorna Hughes and Leo Konstantelos*

© 2018 by the University of Glasgow
This publication may be freely reviewed, copied and redistributed in any medium or format, in part or in whole, but not for sale or for use in conjunction with commercial purposes. Any changes to the text of this publication must be approved by the author and the University of Glasgow. Due credit must be given to this publication.

Acknowledgements

The Scottish Heritage Partnership was funded by a joint AHRC-EPSRC grant on Immersive Technologies.

Contributions to the development of the policy document were made by staff at the National Trust for Scotland, Glasgow Museums, the National Library of Scotland and Soluis Heritage.

Contact us

Professor Murray Pittock FRSE
Centre for Robert Burns Studies,
7 University Gardens,
Glasgow G12 8QH,
United Kingdom.

Email: Murray.Pittock@glasgow.ac.uk
Twitter: @scotimmersives

<http://bit.ly/scottish-heritage-partnership>



EXECUTIVE SUMMARY

The Scottish Heritage Partnership (SHP) consists of senior staff from the University of Glasgow and the Hunterian Museum, the National Trust for Scotland, Glasgow Museums, the National Library of Scotland and Soluis Heritage, part of the Soluis group (www.soluis.com), which is a major provider of cutting-edge immersive visualisation.

The Scottish Heritage Partnership was established by an EPSRC-AHRC award on Immersive Experiences. Its goals were to explore the audience data of immersive experiences of all kinds in Scotland, and to provide evidence for design and procurement values in Immersives for the heritage industry. Its core questions were:

How successful are the current approaches to immersive technologies at major heritage sites in Scotland?

What kinds of future development in procurement and design are supported by the evidence?

Arising from these questions, SHP's core objectives were to:

- Address the efficacy, existing practice and future potential of immersive experiences and technologies in the cultural heritage industry
- Explore how to best harness and shape cutting-edge digital technology to create effective immersive cultural heritage experiences
- Assess how to develop effective, meaningful content into leading edge inclusive and impactful immersive experiences, and
- Produce an evidence-based, decision-making and risk assessment model and visualisation tool for developing immersive technologies in the cultural heritage sector.

SHP defined Immersive experiences as including not only Virtual, Augmented and Mixed Reality, but also experiences generated by audio, video, olfactories, interactive media and replicated or themed environments. We took the view that while VR and AR were central to the future development of Immersive experiences, it would be worth exploring the complementarity between different kinds of experiences. The evidence bore this out.

An international Advisory Board was set up to support the partnership.

Virtual Reality (VR) provides a digital simulated world that the user is fully immersed in from a visual perspective, generally through a Virtual Reality headset (e.g. Oculus Rift, Sony PS Morpheus, HTC Vive, Google Cardboard, Samsung Gear VR).

In **Augmented Reality (AR)**, virtual reality is blended with the physical world. A user can see and interact with virtual objects in the real world with a special headset (e.g. Microsoft HoloLens, CastAR, Google Glass) or handset (e.g. overlap computer-generated content shown on the screen of their mobile device to the real environment). Furthermore, 3D audio/surround sound and haptic technology where force or vibration can be used to create a sense of touch can enhance or alter the dimensions of the sensory experience.

Despite the opportunities afforded by immersive experiences – and relevant investment in such experiences in Scotland – there has often been a lack of substantive evidence (in either scholarship or practice) to evaluate current approaches and guide future developments.

SHP set out to explore the evidence supporting audience development in this area in a Scottish context. But unlike some other research on Immersives, it also remained open to more traditional forms of immersive experience: multimedia, recreated historic environment (as at Riverside, or the Loch Tay Crannog), themed garden space (as at the Burns Birthplace Museum) and olfactories, an area which can be overlooked in contemporary Immersives, though there are new developments in this area through the Innovative Design funding stream and elsewhere. It has become clear over the last fifteen years of development of immersive experiences that these support cultural tourism: according to the Centre for Economics and Business Research (CEBR) 2013 figures, cultural tourists spend one-third more than the average tourist. There is, however, an issue over the ready marketability of VR content mostly held by large institutions when the suppliers of content based experiences are mostly microbusinesses or SMEs.

VR presents a challenge to interactivity, and such interactivity is central to the interests of the core VR/AR demographic. The National Endowment for Science, Technology and the Arts (NESTA) findings clearly showed that VR/AR experience was optimized in cases where the user enjoys a ‘sense of intuitive interaction with their virtual environment, along with a sense of agency within the environment’. In its turn, this helped to support one of the primary USPs of more recent applications of VR: its ability to elicit certain emotions, among them ‘empathetic experiences, allowing users to see things from the perspective of others’. The effects of *transportation*, *translocation* and *transmutation* (including *empathic effects*) have thus started being characterized as central assets in VR experience. Trends in the sector identified in recent National Media Council Horizon Reports, include an increasing trend towards personalized experiences (such as social media, emails, mobile phone apps, internet-connected pens, iBeacon and Eddystone) and mobile content¹.

Our findings suggested that these demands are indeed evident, being particularly present in the under 35 demographic. More pro-active targeting of elements of these groups is regarded as likely in the future, as VR/AR supported by appropriate narrative provides a potentially large advantage in the marketability and memorability of experiences, not least in retail. It is also expected that in the future, the visitor experience will be monitored, individualized and optimized through the greater deployment of metrics arising from smart building technology.

The research tools used by SHP can be summarized as follows:

- **A Review of Trends** in the sector included the use of recent major reports on the VR/AR industry and its markets compiled by NESTA, Innovate and other major UK think tanks and industrial strategy stakeholders, as well as a review of existing audience data from our partner sites and alternative sources of feedback (e.g. TripAdvisor, social media comments).
- **Quantitative Research** was carried out by questionnaire at six sites (Bannockburn, Burns Birthplace Museum, Culloden, Kelvingrove, Riverside, National Library of Scotland at Kelvin Hall).
- **Qualitative Research** was carried out through observations and semi-structured interviews at a selection of these sites and through discussions with heritage professionals in all three of our partner organizations, who are in the process of major change in the ways in which they reach out to visitors and the wider public.

The Project used the outcomes of existing audience data to design an Immersive specific questionnaire which was distributed in a curated fashion (that is, members of the project team were on hand to discuss the issues it raised) across six sites, including the National Library at Kelvin Hall, with aggregate annual visitor numbers of 3 million across these sites.

Our audience demographic was younger than that associated with the average visitor to such sites, with 40% under 35. Given the very different character of the sites included in our research, the audience response we received to very differing kinds of experience was on the whole very consistent. This policy paper should be read in conjunction with the digital decision-making tool designed by our industry partner Soluis, which summarizes the major issues raised, and is available on our website: <http://bit.ly/scottish-heritage-partnership>

Our research suggests that a funder or a cultural organization about to procure a VR/AR package in the context of designing or redesigning a site should ask a number of questions about what kind of immersive experience they want, and what they want it to achieve, regarding audience demographics, the nature of the Immersive experiences and which senses it engages, what it should complement or replace, ongoing maintenance costs, delivery methods and whether presentational style will favour certain demographics.

The trends and issues surveyed across all sites related to mixed kinds of immersive experiences (VR, video games, surround video, multimedia rooms, reconstructed interiors, themed outdoor spaces). We found that:

- i. Audiences like immersive experiences, but prefer mixed virtual and physical experiences with a blended experience and a strong storyline
- ii. In entirely virtual experiences, they prefer the option of handling objects alongside the experience
- iii. In this case, physical objects are best, but even virtual object handling is preferred to a purely virtual environment
- iv. Over 55s (the core tourist visitor demographic) prefer mixed experiences most clearly and (together with 35-54s) engage less with them
- v. Under 35s are the most comfortable with entirely VR experience, and were 46% more likely to engage with it when offered.
- vi. Journey flow makes little difference to response, although it does to experience and dwell time.
- vii. Content and information were regarded as important, irrespective of the mode of delivery: 'less gimmicks and more content'. Narrow or limited narrative restricts the effectiveness of digital Immersives. Intangible heritage requires a thickening of the narratives of contemporary museological practice.

Recommendations are at the end of the full report.

FULL REPORT

AUDIENCE RESPONSE TO IMMERSIVES: THE EVIDENCE



1 PROJECT BACKGROUND

The Scottish Heritage Partnership (SHP) was set up in 2017, and received initial funding in 2018-19. The Project was funded by the Immersive Experiences call from UK Research and Innovation, led by the Engineering and Physical Sciences Research Council (EPSRC) with Arts and Humanities Research Council (AHRC) involvement. It consists of staff from the University of Glasgow/ The Hunterian Museum, the National Trust for Scotland, Glasgow Museums and the National Library of Scotland. The Soluis Group (www.soluis.com), a major provider of cutting-edge immersive visualisation, with clients including the British Museum, were the industry partners through their Soluis Heritage brand. Staff engagement was secured at a senior level in all these organizations².

The aim of SHP was to establish how successful approaches to immersive experiences at major heritage sites are at present, and what kinds of future development are supported by the evidence of audience response. The Project appraised the use of immersive experiences in heritage institutions to evaluate current practice, influence future policy and improve the level of market information to heritage clients and industrial partners going forward. Its core objectives were to:

- **Address the efficacy, existing practice and future potential of immersive experiences and technologies in the cultural heritage industry**
- **Explore how to best harness and shape cutting-edge digital technology for immersive cultural heritage experiences**
- **Assess how to develop effective, meaningful content into leading edge inclusive and impactful immersive experiences, and**
- **Produce an evidence-based, decision-making and risk assessment model and visualisation tool for developing immersive technologies.**

The premises of the project were that while Immersive experiences have the potential to extend audience footprint and deeply engage the museum, gallery and heritage audience, supporting social inclusion and economic impact, it remains the case that current VR/AR commissioning in heritage lacks an evidence base, and that the practice-based, critical framework for decision making that currently exists has often been limited in its evidence base.

Rapid growth of the heritage sector has necessitated a pragmatic approach, and as a consequence-and in view of the rapidly changing nature of the technologies available-there is a need to build a platform to share experience, at a national level. The project was established to make significant contribution to this evidence based model, and present it as a decision making tool for the cultural and creative industries (CCIs).

2

PROJECT PARTNERS

The Project was designed in a particularly Scottish context, but with wider applicability informed by international research. Tourism—not least Cultural Tourism—is becoming central in the global economy. In Scotland tourism is worth some £6bn annually, ca. 5% of Scottish GDP, and supports 196 000 jobs. Tourist numbers exceeded 15m visitors in 2014, with 17m visits to culture and heritage sites in Edinburgh and Glasgow alone. The centrality of cutting-edge immersive experiences for audience development in tourism and the heritage industry has been increasingly evident in recent years, with the development of the Robert Burns Birthplace Museum (2009); The Battle of Bannockburn (2013), and other venues.

The Partners all have a major role to play in the visitor economy:

Glasgow Museums provides the most complete civic museum offer and the most popular in the UK outside London. It has also worked hard through both inspired leadership and well planned policy to create one of the most diverse audience demographics, with 25% of Riverside visitors in the first year of operation having no previous experience of visiting a museum or cultural site. Glasgow Museums run the largest civic museum and gallery offer in the UK in terms of visitor numbers, with their nine museums attracting 4 million visitors a year. Riverside, which is effectively Scotland’s national transport museum, attracted 1.36 million visitors in 2017, with 1.3 million visiting the Kelvingrove Art Gallery and Museum, 671 000 the Gallery of Modern Art, 356 000 the People’s Palace, 235 000 the Tall Ship and 157 000 St Mungo’s Museum of Religious Life among other locations. The combined Kelvin Hall facility (where Glasgow Museum is one of the three partners, together with the University of Glasgow / The Hunterian, and the National Library of Scotland) attracts 1 million annually.

Glasgow Museums use a variety of reconstructed immersive environments including the Street at Riverside and multimedia and games. Glasgow Museums have an outstanding record in extending audience demographics beyond traditional museum goers and both in the £43M Kelvin Hall development and in the impending Burrell redevelopment are seeking to combine this expertise with state of the art digital practice. In the £65M Burrell redevelopment project, in order to reach their target demographics of children and families, Glasgow Museums plan to make significant use of digital technology. The Burrell Collection offer (<https://youtu.be/nUoluYR3ly4>) is a new opportunity to widen the audience demographic in this major civic asset.

The Project was designed to offer specific support in this area, as well as to support the development of a more general policy framework relevant to the Burrell’s shift towards Object Cinemas and interactive, narrativised VR/AR environments when the collection reopens with a significant public-facing digital provision that interprets the Collection for Glasgow Museums’ target audiences – Under Fives, Families and Adults, thus aiming to build on the inclusive potential of Immersives.

The **National Library of Scotland's (NLS)** Moving Image Archive at the Kelvin Hall represents a major departure in policy and strategy for the National Library, and a key part of their move towards the curation of image and sound: Kelvin Hall is now serving as the Scottish hub for the £9M UK Sound Archive. Kelvin Hall is also the only physical location outside Edinburgh for accessing NLS's digital copyright holdings. Already, NLS provision at Kelvin Hall (with innovations such as its pop-up exhibitions) has led to a number of shortlists or awards including a shortlisting for the 2017 Alzheimer's Society prize and the extension of the already generous opening hours in response to popular demand. The NLS has developed its outreach comprehensively and Scotland-wide in recent years, with almost 140 000 people attending NLS exhibitions, workshops and events in 2017.

The **National Trust for Scotland (NTS)** operates 130 properties and has an estate of 76 000 hectares, compared to the National Trust's 350 properties and 247 000 hectares. Operating an estate 30-40% of the size of the National Trust on a population base of under 10% of that of England, Wales and Northern Ireland combined is a major challenge, and the NTS has already made and is planning further innovative decisions in developing its visitor offer, and in reaching a wider demographic. In Project Reveal, it has embarked on the cataloguing and digitization of its entire material culture holdings, while it is also developing a plan to be an SQA accredited centre for volunteering skills. Currently, the NTS's 3800 volunteers offer 191 000 hours of annual support to the organization. Project Reveal, which covers 43 of the NTS's 130 sites is creating a significant range of digital content which can be used in future applications. In total, NTS has some 300 000 artifacts.

In recent years, the NTS has installed several kinds of immersive and interactive experiences. These include the CyArk (<http://www.cyark.org/>) battle experience at Bannockburn (2013); the multimedia Burns experience (2009); and the revised Culloden experience (2007, with subsequent upgrades). With 164 000 visitors, the Burns Birthplace Museum is now the third most visited Trust property and second only to Shakespeare in visits to the homes of famous writers. Culloden's 181 000 visitors make it the most visited audited battle site in the UK, running ahead of Hastings (Battle Abbey) in 2017. Bannockburn is the third most visited battle site in the UK, with 55 000 visitors in 2017.

Soluis Digital, a SME with around 100 employees in Glasgow, has a strong focus on heritage-related expertise. Clients include The British Museum, Samsung Digital Discovery Centre, English Heritage, Sainsbury Institute for the Study of Japanese Art and Culture, Paisley City of Culture 2021 and the University of Glasgow, who are co-operating with Soluis' brand Sublime on a £1M three year Innovate funded project on VR development for the classroom.

An international Advisory Board was set up to support the partnership³.

3

PROJECT CONTEXT

The centrality of cutting-edge immersive experiences for tourism, the heritage industry and audience development has been increasingly evident in recent years. The development of immersive experiences at ‘fantasy’ venues such as the London, York, Blackpool and Edinburgh ‘Dungeons’ from Merlin Entertainments is a related activity. Some of these visitor experiences are a relatively recent development. However, there is some evidence that fully or predominantly CGI-based immersive experiences are less appealing and effective to a comprehensive audience demographic than they are to particular groups (e.g. families with children).

Earlier research has shown that the use of VR for supporting learning in cultural heritage settings produces mixed results⁴. Immersive experiences are means of ‘composing’ memory: they have arguably similar effects to electronic mass media in the composure of memory⁵. In the motorized era, trails have fulfilled the same function of embedding preferred memory narratives, while immersive experiences-delivered in part or whole through the medium of technology-strive to present a fusion of memory, place and performance to create a close and lasting relationship of visitor memory to the experience purchased by the visit. However, scholarship in this area typically lacks a close symbiosis with the technological developments in the private and heritage sectors.

Immersion ‘can be categorised into being immersed in a space (spatial immersion) and being mentally immersed (strategic immersion, narrative immersion and tactical immersion). Immersive experiences describe all forms of perceptual and interactive use of technologies and physical spaces in order to create a *hybrid reality*, in which visitors feel ‘part of the experience as a whole, encompassing all spheres of attention’ – immersion can be Sensory (with audio-visual, olfactory, haptic elements), Challenge-based (interactive) and/or Imaginative (with an emphasis on narrative and interpretation). For tourism and cultural heritage, immersion represents a pathway towards a *mixed-mode experience economy*, which reflects the nuances of differing experience dimensions embodied by different elements of a site. In this mixed-mode experience economy, visitor engagement combines activities across the ‘Realms of an Experience’⁶.

The three pillars of immersive experiences are visual quality, sound quality, and intuitive interactions. Full immersion can only be achieved by simultaneously focusing on the broader dimensions of these pillars, as in Figure 1 below.

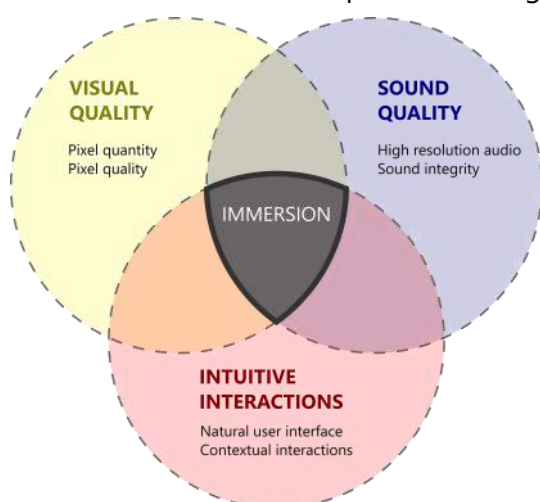


Figure 1. Full immersion by focusing on the broader dimensions⁷

VR/AR Immersive experiences can be 3D (handheld, glasses, autostereoscopy) or 4D. They can be experienced in a full dome or holographic environment (Figures 2 and 3).



Figure 2. The Nintendo 3DS uses parallax barrier autostereoscopy to display a 3D image.



Figure 3. Screenshot from presentation at the Fulldome Institute (left)⁸; holographic representations of the Antikythera mechanism at the National Archaeological Museum in Athens⁹.

Virtual Reality (VR) provides a digitally simulated world that the user is fully immersed in from a visual perspective, generally through a Virtual Reality headset (Figure 4).



Figure 4. Examples of VR headsets. From top left to bottom right: Oculus Rift, Sony PlayStation VR, Google Cardboard, HTC Vive and Samsung Gear VR¹⁰.

In **Augmented Reality (AR)**, virtual reality is blended with the physical world. A user can see and interact with virtual objects in the real world with a special headset, handset or smartphone device (Figure 5). 3D audio/surround sound and haptic technology where force or vibration can be used to create a sense of touch can enhance or alter the dimensions of the sensory experience.



Figure 5. Examples of AR technologies. From left to right: Microsoft HoloLens, Google Glass, and the Pokémon Go augmented reality mobile game for iOS and Android devices¹¹.

Interactive Immersives can make use of speech recognition and motion gesture technology (e.g. Siri, PlayStation Move), Omni-directional treadmills (that allow a user to move in multiple directions within a virtual reality) and other interface technologies more used in medical than recreational contexts.

The use of VR/AR continues on an upward trajectory. By Q1 2017, 6% of the UK population owned VR headsets, a rate of adoption more rapid than either tablets or wearables at a similar stage in development¹². The UK as a whole has around 1000 'immersive-specialist companies' in search of 'the potential audience appetite, cultural impact, and commercial opportunity in the future'¹³. The creative and cultural industries are to the forefront in providing a market for these new developments: for example in the £16M Wicker Man experience recently announced at Alton Towers, contracted to mixed reality solution leader Holovis by Merlin Magic Making (MMM)¹⁴.

Despite the opportunities afforded by immersive experiences – and relevant investment in such experiences in Scotland – there has been a lack of substantive evidence (from both scholarship and practice) to evaluate current approaches and guide future developments.

SHP set out to explore the evidence supporting audience development in this area in a Scottish context. But unlike some other research on Immersives, it also remained open to more traditional forms of immersive experience: multimedia, recreated historic environment (as at Riverside, or the Loch Tay Crannog), themed garden space (as at the Burns Museum) and olfactories. These are often popular and can be cheaper long term in terms of maintenance and upgrades than their digital equivalents; Scotland's olfactory attractions are arguably underdeveloped by comparison with English or Irish provision such as Jorvik and Dublinia. It is worth noting that gardens are a greater source of visitor satisfaction than interiors or collections for the National Trust for Scotland, and that audio immersive experiences (for example in the Historic Royal Palaces' acclaimed Lost Palace exhibition on Whitehall, which utilized location based sound dependent on distorting i-Phone based audio) are among the most acclaimed of modern Immersives. Such Immersive developments support an expanding footprint for cultural tourism, and cultural tourism (as cited in the CEBR figures above) delivers a higher spend¹⁵.

Alignment between content generation and commercial and heritage sector provision is an important current and future consideration for maximizing the impact of the heritage industry on cultural tourism. The volume of data being created in archaeological research alone through everything from digital photography to 3D modelling and scanning is huge, and it is important that it finds an appropriate route to market or simply reaches the widest

possible audience through museum and national collection facilitated knowledge exchange. Research on the nature, expectations and consumption patterns of what constitutes compelling content is still at an early stage. This is important because with the generation of ever larger amounts of digital data (for example via the National Trust for Scotland's Reveal project or the National Library of Scotland's aim to digitize one-third of its holdings by 2025) is creating huge opportunities for appropriate content generation.

This provides challenges in the IP sphere which the content creators in the immersive sector -typically micro businesses with an average of fewer than five employees-will find it challenging to meet. The appetite for change is growing rapidly, with the National Trust for Scotland laying fresh stress on variety, programming, and engaging visitors interactively, as well as laying a new found stress on the emotional dimension of the visitor experience. NTS interest in developing the appeal of interiors is also important, as these are some of the major assets of their visitor attractions, and of course provide multiple opportunities for AR provision. As a less-is-more strategy involving the rotation of artifacts with fewer on show at any one time develops, it offers opportunities for an increased digital presence for artefact displays. NTS already collaborate with ArtUK, Google Expeditions and the Google Cultural Institute in this space. Providing a stronger commercial footprint from collections and interiors is also a medium term priority¹⁶.

When it comes to issues of content creation, there can be a variable attitude to the value of copyright among the copyright holders of cultural digital image archives. Many heritage and collections enterprises are large or larger scale businesses in the public, charitable or public supported sectors. Such sectors are associated with cautious management practices and complex processes designed to protect the organizations from risk. There is thus a potential mismatch between the owners of content and the designers of experience in culture, size and processes. The agility of small scale content production faces a structural challenge in securing the right access for the marketization of the huge amount of content being generated by cultural heritage organizations and their repositories. The monetization of culture for the best visitor and personalized experiences in such a culture-rich environments as Scotland and the UK may be a desirable goal, but it will require a careful framework in respect of content provision and consumption which is not explicitly acknowledged in the current place of Immersives in the UK Industrial Strategy.

In 2017, the BBC 'conducted a longitudinal piece of work to study the impact of VR on participants that had previously had little interaction with the technology', which identified an important issue for visitor experiences, namely that

audiences find VR to be a technology that requires undivided attention. Whereas traditional media forms are now dominated by the use of multiple screens, VR provides a space where attention has to be on the content within the headset. This is identified as a unique characteristic of VR, and also a challenge.¹⁷

This has obvious implications for social interaction. NESTA's 2018 research was geared to identifying suitable indicators of appreciation, impact and memorability in immersive experiences. In identifying these three types of experience were chosen: a short fantasy story (standout quality: 'Positive Affect'), a short animated piece showcasing VR functionality ('Engagement') and a conceptual, environmental 'tree-hugging' experience which showed the 'highest global quality score' as a result of its capacity to give 'Unusual Perceptual Experiences'. Findings clearly identified aspects of VR common to other media, for example a preference for cultural experiences which are capable of 'delivering powerful, compelling experiences and great storytelling', as well as those more centrally served by VR/AR: 'the idea that the experience was putting you into another place, person or time'.

This experience was optimized in cases where the user enjoys a 'sense of intuitive interaction with their virtual environment, along with a sense of agency within the environment'. In its turn, this helped to support one of the primary USPs of VR: its ability to elicit certain emotions, among them 'empathetic experiences, allowing users to see things from the perspective of others'¹⁸. The effects of *transportation*, *translocation* and *transmutation* (including *empathic effects*) can thus be characterized as central assets in VR experience; *transportation* in time might be the NESTA research did not explore this-better served by Augmented Reality (AR), and this should be borne in mind in the evaluation of new commissions in heritage and collections.

The extent to which AR may offer a better solution to some kinds of cultural experience (for example in the 2018 Ashurbanipal British Museum exhibition) did not arise in framing our research questions, but arose as our research progressed. VR can also be seen by users as unsurprisingly perhaps in light of its transformative effects-a source of agency 'as opposed to other, more passive forms of media'. The NESTA research suggests that 'Mixed media with or without location-based experiences, such as immersive content that relates to and extends existing content (e.g. TV series, film) were seen as a key opportunity'¹⁹. Our research (below) was to suggest that interactivity was often most important to the demographics most likely to be open to new technology.

Trends in the sector identified in recent National Media Council Horizon Reports, include an increasing trend towards personalized experiences (such as social media, emails, mobile phone apps, internet-connected pens, iBeacon and Eddystone) and mobile content. Our findings also suggest that these demands are evident, particularly in the under 35 demographic. More pro-active targeting of personalized elements to these groups is therefore regarded as likely in the future.

The latest generation of VR/AR experience includes Activity Simulators, which are task-oriented and have significant educational potential, and include products such as The Climb by Crytek GmbH for Oculus Rift or Short Fiction, with strong character and narration, typically delivered in 360 degrees over 5-15 minutes, with products such as *Miyubi* by Feliz & Paul Studios/Funny or Die for Samsung Gear, which put the player in the mind of a toy robot. Both of these genres have considerable potential to develop interactive experiences at heritage and collection sites, as do Data Visualisers (for example by tagging historic furniture, paintings or interiors, of which the AR app Viewranger Skyline is a key example). Mediaeval or ancient sites might be fruitful ground to develop Immersive Maker Tools to help users create their own virtual object environment and Perspective Shifter, which enables the visitor to see through the eyes of historic characters in a transformational development of 1990s animatronics with the new ability to create empathy; Immersive Maker Tools can also serve to create a more social experience for VR, which can be perceived as being isolating. *Treasure Hunt* can also engage a wider audience: as is the case for example through the England's Historic Cities app. There is clear future potential for bundling digital enhancement packages into subscription models for heritage organizations²⁰.

Audience data in respect of these-so far derived from a female dominated focus group of early adopters of the technology – indicates that the most successful creative formats with this target audience were Immersive Maker Tools and Activity Simulators. The appeal of personalized content was central:

The most successful formats provided the material for the audience member to create their own, personal narrative. Academics and game theorists have described this style of narrative as an emergent narrative - a format that supplies the raw material and structure for the audience member's own storification process to occur. More recently, VR industry leaders have described this user-centric approach to narrative as storydoing or storyliving.

Recent research from the EMOTIVE EC H2020 project team has also emphasized the central role narrative plays:

Despite offering tools for personalization and even when they adopt storytelling approaches, virtual museums have largely followed the wider tendency in the cultural heritage sector to **use narrative narrowly**, as a method to communicate to the public the findings and research conducted by the domain experts of a cultural site or collection.²¹

Such narratives can be part of personal experiences that renders visits to cultural sites 'to be more lastingly remembered, restorative and sometimes transformative'²². Recommendations from the EMOTIVE conceptual framework conclude that visitor experiences should

- adopt a story-based rather than an object-based approach, supporting interaction between (virtual) characters as well as real visitors, as well as engagement with the objects;
- blend the online with the on-site experience;
- seamlessly integrate the pre-, during, and post-visit activities, and the intangible with the tangible;
- cater to the dominant visiting patterns of museums and cultural heritage sites, which primarily see groups of visitors participating in social experiences with varying - sometimes conflicting - individual motivations;
- integrate exploration of hybrid 2D/3D spaces in meaningful ways which support the storytelling and the social and emotionally-engaging experience of the visit.

VR/AR supported by appropriate narrative provides a potentially large advantage in the marketability and memorability of experiences. The Event Marketing Institute and experiential agency Mosaic publish an annual survey on experiential marketing research, which provides insights into the effectiveness of experiential marketing. Findings in the 2016 edition were as follows:

- 74% of event attendees say that they have a more positive opinion about the company, brand, product or service being promoted after the event.
- 70% of users become regular customers after an experiential marketing event.
- About 34% of consumers surveyed said they would make a post about an experience on their social media pages.
- 98% of users feel more inclined to purchase after attending an immersive activation.

This strongly suggests that retail strategy should and could be integrated into the design of a VR/AR narrative designed to support a distinctive and personalized visitor experience. Given the importance of merchandising in visitor experiences, this offers a number of future opportunities.

Future environmental changes arising from broad AI developments should also be factored in in considering the potential of Immersives. In these futures, the visitor experience can be monitored, individualized and optimized through the greater deployment of metrics arising from smart building technology, while AI 'personalities' and cityscapes can be preserved through ongoing digital archiving, meaning that 'generations to come may be able to

interact with their ancestors, learning from them and potentially even building relationships with them²³.

Proprietary communication protocols are too segmented within these businesses at present. However, smart buildings are estimated to have the capacity to save the UK economy £135bn annually by reducing operating costs by 30%, and the 2017 European market already stood at some \$83.5 bn. The incentives are such that internal connectivity is likely to develop rapidly from here. Although the vast bulk of the market is likely to be industrial and commercial, smart buildings have the potential to channel visitors to heritage and culture sites optimally and also to provide some personalization of the experience, both increasingly important elements at major sites. Since heritage and collections on the whole do not generate enough income to offer large-scale direct employment, the automation of aspects of the visitor experience should serve to lessen the pressure on volunteer labour, rather than removing paid roles from the job market. There is great potential for major shifts in experience automation in the UK, which has only 71 robot units per 10 000 employees, compared to 189 in the US and 303 in Japan²⁴.

Improving experience for repeat visits and visitors is also an outcome of the technology. While castles, historic houses and so forth may find it less easy to benefit, designed visitor centres and experiences and digital museums look to be major beneficiaries of this technology going forward.

4 METHODOLOGY

The first step was to identify previous research on the topic under consideration and to place the study to be conducted in the framework of the wider literature. The research tools included site visits during which we employed direct observation, semi-structured interviews with end users/visitors as well as staff at culture and creative industries, recording and taking photos as well as the study of social media accounts, and written and archival documents. Research was carried out at six sites: Bannockburn, Burns Birthplace Museum, Culloden, Kelvingrove, Riverside, National Library of Scotland at Kelvin Hall. GDPR and ethics protocols in line with the University's practice and the legal framework were established and followed in constructing the following range of approaches:

- **A Review of Trends** in the sector included the use of recent major reports on the VR/AR industry and its markets compiled by NESTA, Innovate and other major UK think tanks and industrial strategy stakeholders, as well as a review of existing audience data from our partner sites and alternative sources of feedback (e.g. TripAdvisor, social media comments).
- **Quantitative Research** was carried out by questionnaire at the six sites.
- **Qualitative Research** was carried out through observations and semi-structured interviews at a selection of these sites and through discussions with heritage professionals in all three of our partner organizations, who are in the process of major change in the ways in which they reach out to visitors and the wider public.

Research Risks included the fact that the extent of our funding did not allow for evaluating the effects of mobile and sensory impairment on the visitor experience at these sites in a systematic way, and that we lacked data from olfactory Immersives: an underdeveloped area in Scotland.

AUDIENCE PROFILE

The Project received evidence of audience research already collected at immersive sites, including the British Museum, Bannockburn, Culloden, the Robert Burns Birthplace Museum and across the Glasgow Museums offer, as well as feedback from the Samsung Discovery Centre Bronze Age Roundhouse experience at the British Museum, designed by our industry partner Soluis. Of these, only the Roundhouse data was only concerned with eliciting responses to immersive experiences.

Glasgow Museums in particular offered valuable data from under 18s, while the aggregate data as a whole reflected the plurality of over 55s as heritage visitors. Children were in a minority at NTS sites, although Bannockburn's strongly VR and interactive offer was reflected in its appeal to this demographic. The data from the Soluis Bronze Age Roundhouse indicated that responses to VR were enhanced by the experience of 'virtual' object handling of the three scanned objects: the Woolaston gold bracelet, a Sussex loop bracelet and a large dirk²⁵.

At sites dominated by virtual Immersives such as Bannockburn, there were strong requests for more interactive material, objects and activities. At the same time, Bannockburn was the site seen as having the strongest appeal to children, with its extensive Virtual Reality/gaming presentation and facilities. It is also the most interactive site. Our research findings confirmed the importance of objects and encounter with materials mentioned in existing audience profiles. Even in the diverse and interactive Burns Museum, there were requests for children in particular to try on period costumes, handle objects or use eighteenth-century farm equipment.

It was recognized that while extensive evidence for evaluating visitor experience was in existence, there was no integrated critical assessment of the effect of immersive experiences at Scottish heritage sites. In addition, there are no readily available guidelines for curators, site managers or researchers that we could trace. A core premise of the research was to provide a detailed framework for conducting descriptive and to some extent explanatory focus groups about selected Scottish cultural heritage sites making use of immersive technology. A balance was chosen among the experiences offered by SHP partners between full scale VR immersive and interactive provision (Bannockburn), video immersive (Culloden), multimedia and interactive games (Burns, Glasgow Museums) and video interactive (National Library of Scotland).

The Project analysed existing audience data to design a standard Immersive experiences questionnaire which was adjusted and customised according to the needs and context of each cultural site. It was distributed in a curated fashion (that is, members of the project team were on hand to discuss the issues it raised and carry out semi-structured interviews) across all six cultural sites included in our study, with aggregate annual visitor numbers of 3 million. A number of questionnaires were also left in peak season to be self-administered, to act as a control for the questionnaires from the face-to-face interviews. The project team also carried out observations of visitor experience. All data was anonymised and collected in accordance with confidentiality, security and GDPR requirements set by University of Glasgow policy and legislation.



Figure 6. The SHP methodological process

The audience demographics of those who completed the questionnaires across all sites were as follows:

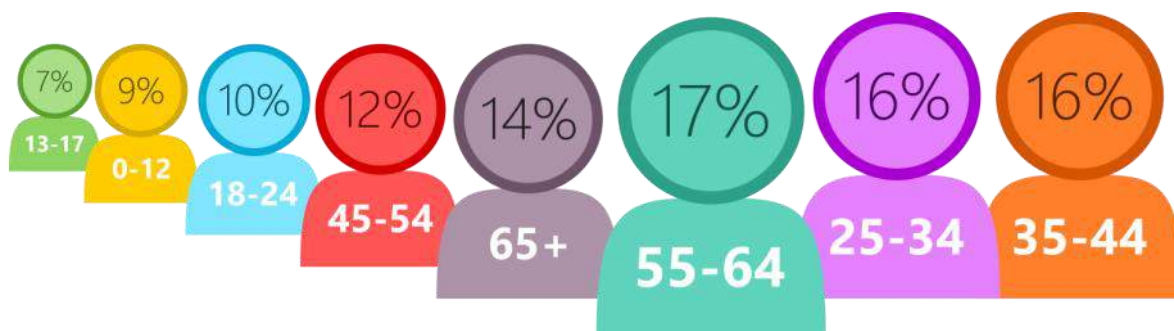


Figure 7. Audience demographics of questionnaires completed during SHP research.

Our under-35 figure was thus much higher (40%) than those recorded in existing audience data (see below), while our over-55 figure (29%) was slightly lower than the average existing audience data. 90.4% of respondents identified as 'white', 5.7% as BAME and 3.6% as other, which is in line with visitor profile for sites in Scotland (see Figure 8).

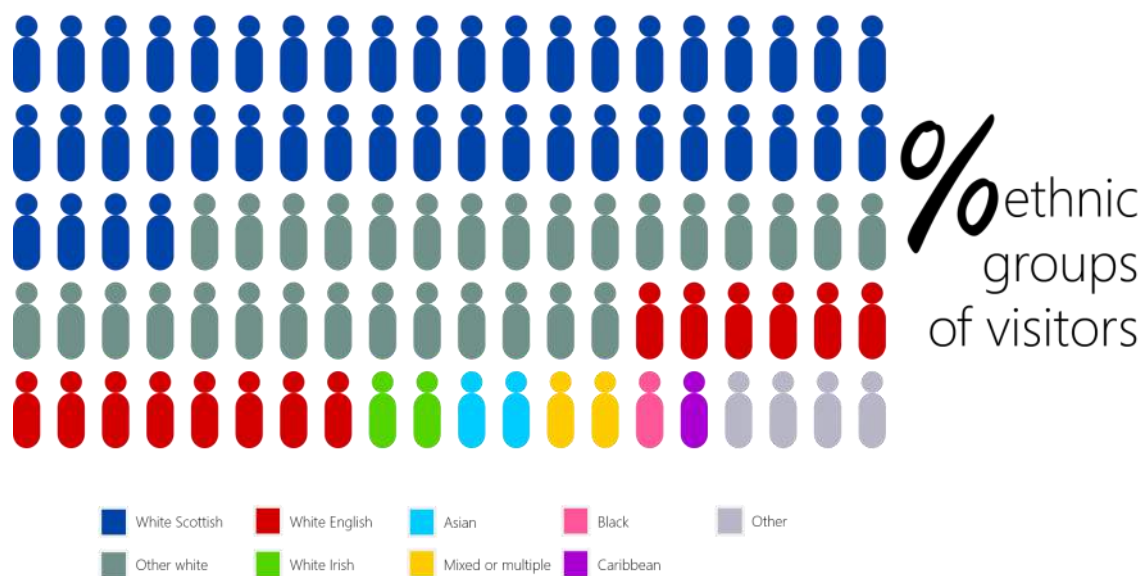


Figure 8. Ethnic group distribution across participants in the SHP questionnaires

60% of respondents came from the UK. 14% were unemployed or in part-time work, 26.4% were studying/at school (Figure 9). 95% were visiting as part of a group.



Figure 9. Employment status across participants in the SHP questionnaires

OUR RESPONDENTS SAID...

'Granddaughter was overwhelmed by the realism of the experience' (Adult, 69, NTS)

'In order to understand and participate in the 3D game more fully, more time is required in the film room in order to absorb the information' (Adult, 66, NTS)

'The travelling audio pieces had a lot of potential but were sometimes distracting' (Adult, 62, NTS)

'Hand held interactive speakers not that great' (Adult, 50, NTS)

'The combination of human narrative, 3D images and game play was excellent-an immersive learning experience for adults and children alike, we loved it!' (Adult, 45, NTS)

'I feel that there isn't enough time in the film room prior to playing the game. I would have liked to have listened to the characters on each side' (Adult, 44, NTS)

'The battle was a unique experience' (Adult, 41, NTS)

'The interactivity of the experience allows a better understanding' (Adult, 40, NTS)

'Subtitles for non-native speakers (or people with hearing impairment) would be great-you have the technology, why not use it for everyone?' (Adult, 36, NTS)

'We would have liked to have tried on helmet, armour and interact with the weapons on display' (Adult, 35, NTS)

'There is space for more immersive tech' (Adult, 26, NTS)

'I really liked the digital exhibits' (Adult, 24, NTS)

'It's a long way away, some parts can be delivered by app or web' (Adult, 24, NTS)

'Would have loved more content on statistics, names' (Adult, 18, NTS)

'None of us were native speakers, so words like cavalry and pikes are a bit too hard' (Teenager, 17, NTS)

'Interactive areas are great. Our children love learning through interactive play' (Adult, 46, Glasgow Museums)

'Toddler loves the digital and media' (Adult, 38, Glasgow Museums)

'I think that including digitals help people understand better especially if they have a learning disability like myself' (Teenager, 16, Glasgow Museums)

'I thought that the info was not enough' (Child, 10, Glasgow Museums)

'I don't like the cars up the wall...You can't fully experience through a screen' (Glasgow Museums)

'I wish students got to have an opportunity to create or exhibit their research' (Adult, 27, NLS at Kelvin Hall)

'I love starting the day by walking down the hall way at Kelvin Hall) and watching the super cool video wall all the way down' (Adult, 22, NLS at Kelvin Hall)

The division of data between the sites and audience response to the main strands of questioning are below. It is noteworthy, given the very different character of the sites that audience response to differing kinds of experience was on the whole very consistent.

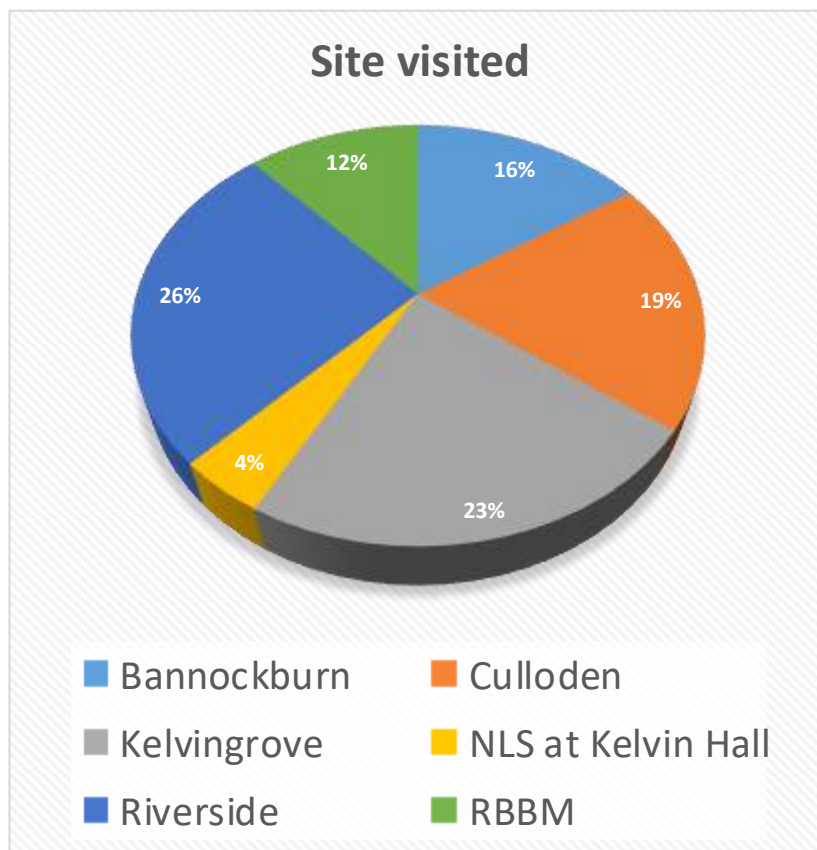


Figure 10. Respondent distribution by site visited

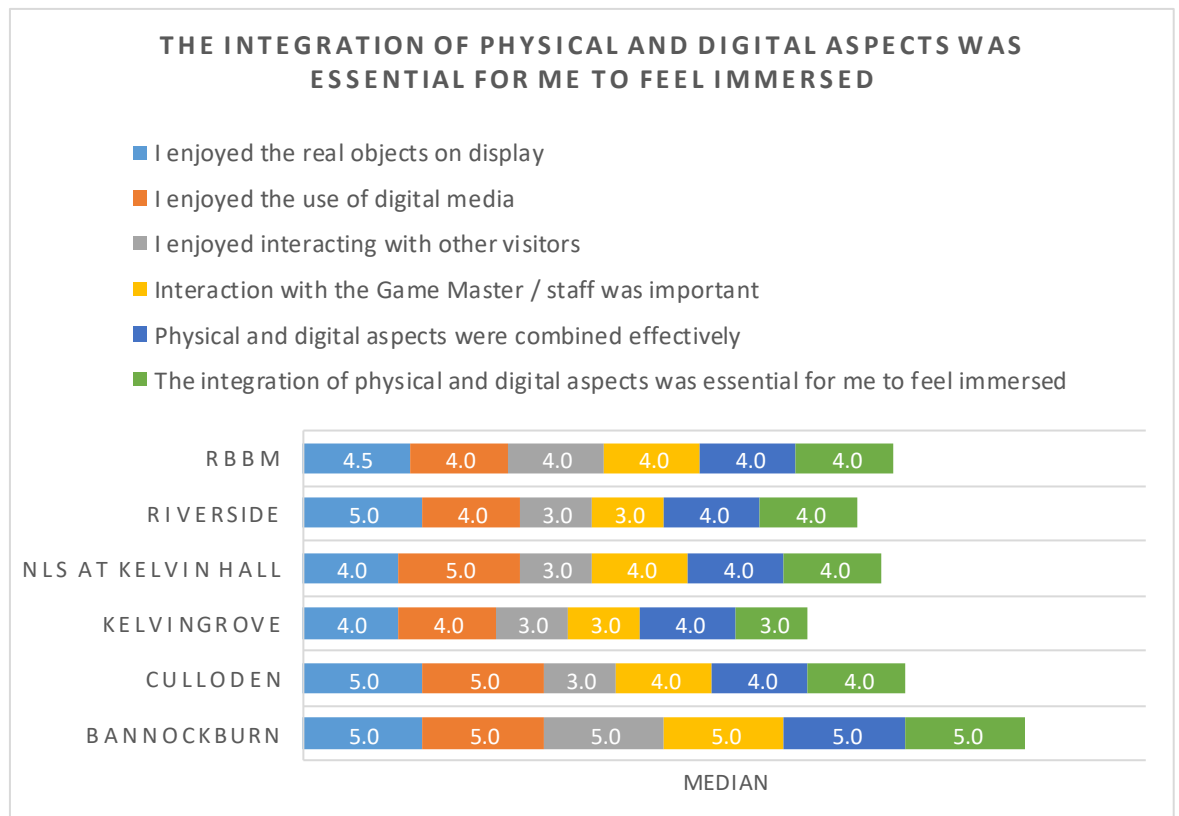


Figure 11. Respondent attitude towards mixed-mode immersion across sites (with 1=Strongly Disagree and 5=Strongly Agree)

There were a number of clear findings supporting the recommendations that follow arising from the project. This policy paper should be read in conjunction with the digital decision-making tool designed by our industry partner Soluis. This summarizes the major issues and criteria which need to be considered for future decision-making in the areas of immersive technologies in cultural heritage arising from the findings of the project. This Soluis tool is freely available on the project website as a resource illustrating the creative and critical processes, and key decision points which need to be followed when developing immersive technologies for a cultural heritage environment.

5

OUR RESEARCH FINDINGS AND ANALYSIS

The trends and issues experienced across all sites related to mixed kinds of immersive experiences (such as VR, video games, surround video, multimedia rooms, reconstructed interiors and themed outdoor spaces).

WHAT WE FOUND

1. Audiences like immersive experiences, but prefer mixed virtual and physical experiences with a blended experience and a strong story-line.
2. In entirely virtual experiences, they prefer the option of handling objects alongside the experience.
3. In this case, physical objects are best, but even virtual object handling is preferred to a purely virtual environment.
4. Over 55s (the core tourist visitor demographic) prefer mixed experiences most clearly and (together with 35-54s) engage less with them.
5. Under 35s are the most comfortable with entirely VR experience.
6. Journey flow makes little difference to response, although it does to experience and dwell time.
7. Content and information were regarded as important, irrespective of the mode of delivery: 'less gimmicks and more content'. Narrow or limited narrative restricts the effectiveness of digital Immersives. Intangible heritage requires a thickening of the narratives of contemporary museological practice.

Taking into account the footprint, floor plans and external space adjacent to these properties, it is clear that Bannockburn's full scale VR and interactive battle game tended to increase dwell time on a like for like basis. Bannockburn is very much smaller than the Burns Museum/Cottage experience and was much less expensive to develop; it also has less to offer out of doors than Culloden. The main exhibition space is 28.1x14.5 metres and the 'Battle Room' has a diameter of only 7.8 metres; but the dwell time at Bannockburn is very close to that at Culloden and the Burns Museum, being in every case around two hours. It must be surmised that this is due to the extent that Bannockburn provides an interactive experience, although there may well be other factors, such as the greater number of children among site visitors. The VR/interactive game at Bannockburn became the focus of the visitor experience; this had the advantage of extending dwell time, but the disadvantage of leading to relatively high levels of demand for other kinds of experience. More varied combinations of digital/analogue experience (as at the Burns Museum) tended to have lower take-up rates but wider utilization, at the price of a less focused experience. There was some evidence of the identified NMC trend towards a greater personalization of the experience, and more recognition of the individual visitor's needs. 100% of Bannockburn visitors polled visited the immersive game, while Burns Museum visitors were split between the interactive museum (86%), the Cottage (76%) and the immersive Burns themed garden (72%). At Culloden, 81% visited the battle immersion, but only 42% the Battle table.

Glasgow Museums (GM) visitors showed a preference for 'doing', 'touching' and clips rather than longer videos and games in their own audience data. Under 18s showed a strong preference for interactivity, not least through games and quizzes. GM visitors also showed a strong interest in the linkage between physical objects and digital experiences. Unsurprisingly, GM research showed the importance of experience location in promoting visitor engagement, with the interlinking between objects and digital a particularly important consideration, as well as alignment between the performance of digital resources and visitors' experience of their own devices. The role of well-evidenced space planning in the design and implementation of successful Immersives or interactives also came through strongly from our research. GM research also suggested that while mobile networked devices were important for Museum visitors, phones were mainly used for photography and apps were not heavily used. Families were the key to mobile use. Some 43% use the interactive games at Kelvingrove and 32% the video displays; at Riverside, 57% use video interactives, but 75% visit the Subway train and 88% the immersive environment of the Street²⁶.

Visitors to the National Library of Scotland's Kelvin Hall facility were most likely to use the touchscreens supporting interactive themed film choice (69%) to watch the video wall (54%) or to use the collections more generally (54%). Research booths- for many, the primary attraction of a research library- were chosen by only 23%, suggestive of the changing character of the NLS audience at Kelvin Hall.

SHP's curated field research across our various sites suggested that physical objects remain the top reason for visiting heritage sites (4.50 on a 5-point scale), but with digital media (4.22) and combined physical and digital (4.20) very close behind (Figure 12).

Real objects obtained 4 or 5 ratings from 95% of respondents (57% at 5) and appealed most to under 13s (who were most positive about interaction) and over 25s. Interaction in general was less popular (39% positive), consistently scoring in the 3.45-3.54 range. Given the significant differences in demographics here (younger users prefer interaction and the digital, which had overall approval ratings of 81%) there is a clear challenge in that the potentially isolating effects of VR with regard to social interaction may both appeal to and frustrate the expectations of the younger demographic, though it should be noted that findings from other studies indicate that 'VR lends itself to group or social engagement, even though the experiences are primarily individual'.²⁷

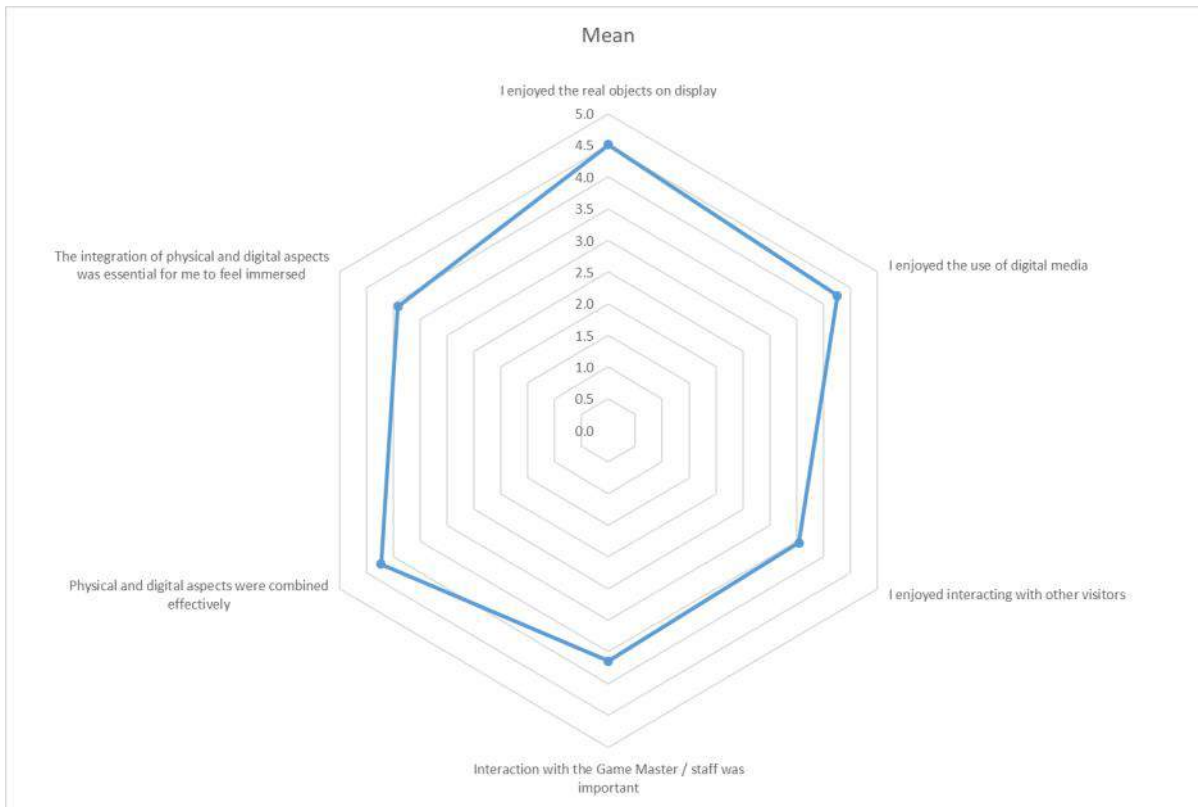


Figure 12. Mean responses of rating experience factors (with 1=Strongly Disagree and 5=Strongly Agree)

However, the readiness of this demographic to accept digital interactivity over conversation offers an important pointer towards the need to build social media friendly and digitally interactive exhibits into any immersive scenario. Some 65% were positive (4 or 5 on a 5-point scale) towards mixed immersive experience and only 8% negative.

The correlation between enjoying the objects on display and the use of digital media was only 0.346, while those who enjoyed digital showed a stronger correlation (0.501) with a combined experience. Interaction with other visitors received only an 0.177 correlation with those who identified as enjoying physical objects, but 0.640 with those who enjoyed interacting with staff. The identification of a combination of digital and physical objects as 'essential' was 0.506 correlated with the view that they were effectively combined and only 0.081 correlated with enjoying physical objects, suggestive of there being a greater bias towards physical objects in heritage offers and displays than the audience response warranted. The overwhelming finding remains that mixed experiences offer the most satisfying balance across demographics, but that considerable scope remains to refine these further.

Our research bears out NESTA's 2018 findings that VR/Immersives benefit from stronger narrative content than the contemporary curatorial norm, and that the only successful substitute for content is an unusual or transformational perceptual experience²⁸. NESTA's research indicates that consumers are willing to pay almost twice as much to experience Immersive content in a public entertainment venue as in a home environment. In demographic terms, NESTA's audience/user sample had a good gender/minority spread and had a high level of prior engagement with arts and culture, but in terms of its goal in establishing a market, there was a clear shape to the selected demographic: 65.5% of NESTA's audience/user sample was under 35, while 60% had previous VR experience²⁹.

This suggests that some aspects of the NESTA findings may need to be treated with caution in the case of heritage and collections sites, where the more typical demographic is over 55. While many heritage providers (for example the National Trust for Scotland and Glasgow Museums) are actively seeking more extended and varied demographics to expand their audiences, there may be some implications in the delivery of changing experiences with regard to securing existing audiences. For example, the introduction of 360 degree effects in computer games early in the 2000s seems to have acclimatized a younger demographic to expectation of effects which can provoke nausea in older consumers of culture, for example those exposed to 'dome' style experiences: hence some recent VR installations have adopted a 270 degree model.

The importance attributed to objects bears out earlier NTS findings about the importance of mixed or hybrid learning environments³⁰. The appeal of mixed Immersives is now borne out from data from other sources too, including the recent Lumina/Digital Catapult report which concluded that 'the most successful formats... tended to generate more than one sort of immersion in their audience'.³¹

6 QUESTIONS FOR HERITAGE PROVIDERS

Museums, heritage and collections are increasingly engaging with the rapid rise of VR/AR and related technologies. The evidence suggests that this technological shift is one taking place in the context of a broader shift in the desire for fresh and more highly personalized experiences. Over investment in a purely technological visitor experience does not guarantee the best outcome, despite its being increasingly necessary to that outcome.

Even digital natives showed a tendency to respond strongly to personal interaction with people or games, haptic experience and conventional objects: the more the senses were engaged in different ways, the better the experience on average across mixed demographics. Moreover, unless the technology was used to create a transformational experience, then there was a stronger demand for thicker and deeper narrative content than that conventionally found in modern curatorial practice. Overdependence on technological visual immersion alone carries a risk not only of failing to engage the audience fully, but also associated risks of cost, equipment failure and ongoing maintenance and upgrades.

Our research suggests that a funder or a cultural organization about to procure a VR/AR package in the context of designing or redesigning a site should ask a number of questions about what kind of immersive experience they want, and what they want it to achieve. These include:

- What is the site demographic, and do I want to adjust or change it, and if so, how?
- How will touch complement sight in the VR elements of the experience?
- Can or should it replace guided tours and audio guides completely?
- Will audibles be needed, and if so can they be subtitled?

- Will certain demographics experience nausea from 360 surround (e.g. fulldome) VR, given the post 2000 appearance of this on the computer games market?
- How many senses are you reaching? Do olfactories (smell) have a role to play, on their own or in 4D?
- Where will the immersive experience be sited, and how will it be mixed with existing content to maximize audience response?
- How will it enhance interpretation and content, and for whom?
- How can we personalize it?
- What physical material should the immersive project enhance / work in conjunction with?
- What is the balance in the visitor experience between a recreated and a virtual environment and why?
- What is the value added by VR/AR, and does it justify the maintenance and development costs of ongoing technical upgrades?
- VR or AR/haptic delivery: what is the comparative efficacy, objectives and costs?
- Can digital content be available in part online with more available on site to engage younger adults and children?
- What other accessibility considerations would be needed?
- What kind of space will the experience be located in?
- How can we get people to come back?
- Who do we want to come back most?

7 RISKS

The major risks associated with the operational use of Immersives, particularly VR/AR Immersives, can be categorized as follows:

RISK	SEVERITY	LIKELIHOOD IN EXISTING SITES	IMPACT (SxL)
Changing audience expectations not reflected in allowances for upgrading software	5	9	45
Narrative content is not adapted for digital delivery	7	6	42
Mixed mode balance is not consciously chosen, leading to dissatisfaction in certain visitor demographics	7	6	42
VR/AR remains immersive without being personalized, with risk of	4	8	32
Different demographic expectations not recognized in VR/AR provi-	3	9	27

8

CONCLUSIONS & RECOMMENDATIONS

Our own research, complemented by bench research and previous audience data from our selected sites indicates the following:

1. VR/AR visual experiences are a core part of the demand for more personalized and distinct experiences for cultural heritage visitors, but the design of such experiences should prioritize the goals of the experience over the technology.
2. Simple recreated environments and interactive games continue to have a strong role to play, and should complement VR/AR.
3. VR/AR provides a potentially large advantage in the marketability and memorability of experiences (see EMI & Mosaic, above) and significant retail development-liberated from its typically small on site footprint-complementary to this experience should be carefully considered and integrated into the planning of Immersive experiences.
4. VR/AR Immersives can maximize the use of smaller experience footprints by increasing dwell time per square metre significantly, and this is one of their key capital cost advantages over more traditionally oriented immersive spaces and should be considered as part of the overall cost/retail/catering aspects of any business case.
5. Quality providers of VR/AR experience are typically small and agile companies in a highly content hungry industry, but VR/AR content suppliers are typically large public sector, public supported or charitable organizations with a slow time to market and conservative views of copyright. It is recommended that incentives are introduced (as they have been to some extent under the UK Government's Audiences of the Future (AOTF) funding programme under the Industrial Strategy) to bring content providers and suppliers closer together.
6. Haptic object experience was popular as was direct experience with objects, which still remain central to the visitor experience.
7. Fuller use could be made of surround sound, audio and olfactory technologies.
8. As with moves in universities towards online, distance and blended learning, it is evident from the audience responses of under 35s that there is increasing appeal for consuming the heritage experience remotely in whole or in part. Further research is recommended on this as it would represent a significant shift in thinking by heritage providers. NESTA research indicating willingness to pay over 50% of the visitor price to consume immersive experiences remotely suggests there is a strong market.
9. Consideration should be given to generational VR expectation and the ability to deal with intense 360 degree experiences among the core over 55 demographic.
10. Additional digital experience to consume at home and/or the creation of virtual visit packages is recommended in order to engage the under 35 demographic.
11. The combination of motion gesture technology with ongoing evidence and research regarding the health and wellbeing aspects of the heritage industry offers important opportunities.

ENDNOTES

1. See for example *Mapping the Museum Digital Skills Ecosystem: Phase One Report*, (Leicester: University of Leicester, 2018).
2. The Principal Investigator was Professor Murray Pittock, Pro Vice-Principal at the University of Glasgow. The Co-Investigators were Professor Lorna Hughes, Chair of Digital Humanities at Glasgow and Dr Maria Economou, Hunterian Digital Strategy lead and Vice-Chair of UNIVERSEUM, the European Academic Heritage Network. Dr David Hopes, Head of Collections and Interiors, represented the National Trust for Scotland, and Steve Colmer, Creative Director of Soluis, represented the industry partners. Duncan Dornan, Head of Glasgow Museums and Dr Robin Smith, Head of Research and Collections at the National Library of Scotland, were also involved. The researchers employed on the project were Dr Agiatis Benardou and Dr Leo Konstantelos.
3. The members of the Advisory Board are Professor Mark O'Neill FMA, formerly Head of Policy, Glasgow Life; Dr Maria Roussou, University of Athens, formerly Head of VR, Foundation of the Hellenic World, Professor Mike Pidd, University of Sheffield, Professor Sarah Kenderdine, University of Lausanne and Ms Patricia Weeks, Antonine Wall Interpretation Officer, Historic Environment Scotland.
4. L. Pujol and M Economou, 'Exploring the suitability of Virtual Reality interactivity for exhibitions through an integrated evaluation: the case of the Ename Museum', *Online International Museology Journal*, 4 (2007): 84-97.
5. Penny Summerfield, 'Dad's Army, the Home Guard, and the Memory of the British War Effort', in *The Lasting War: Society and Identity in Britain, France and Germany after 1945*, Basingstoke: Palgrave Macmillan Ltd. 2008, 86-99; Murray Pittock and Pauline Mackay, 'Highland Mary: Objects and Memories', *Romanticism* 18:2 (2012), 191-203.
6. B.J. Pine and J.H. Gilmore, 'Welcome to the Experience Economy', *Harvard Business Review* (1998); W. Suntikul and T. Jachna, 'The co-creation/place attachment nexus', *Tourism Management* 52(2016), 276-86; *Immersive Content Formats for Future Audiences*, Limina Immersive for Digital Catapult, 2018, 5.
7. Adapted from: Qualcomm, "Driving the New Era of Immersive Experiences", *Qualcomm Technologies White Paper* (2015), 6.
8. Image by Mgr. Leo Nitce [CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0>)], from Wikimedia Commons.
9. Image by Grb16 [CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0>)], from Wikimedia Commons.
10. Images by Sebastian Stabinger [CC BY 3.0 (<https://creativecommons.org/licenses/by/3.0>)], from Wikimedia Commons; Maurizio Pesce [CC BY 2.0 (<https://creativecommons.org/licenses/by/2.0>)], via Wikimedia Commons.
11. Images by Ramadhanakbr [CC BY-SA 4.0 (<https://creativecommons.org/licenses/by-sa/4.0>)], from Wikimedia Commons; Antonio Zugaldia [CC BY 2.0 (<https://creativecommons.org/licenses/by/2.0>)], via Wikimedia Commons.
12. *VR: A Deeper Perspective*. YouGov, 2017.
13. *Evaluating Immersive User Experience and Audience Impact*. Innovate, Digital Catapult, NESTA and i2 Media Research, 2018, 1.
14. 'A Burning Desire for a New Rollercoaster Experience', *AV Technology Europe*, September/October 2018, 65-67.
15. For more detailed discussion of these findings, see Murray Pittock, Robert Burns and the Scottish Economy, (University of Glasgow: Centre for Robert Burns Studies, 2018), Preliminary report for Economic Development, Scottish Government.
16. *Experiencing Things*, National Trust for Scotland, 2018; NTS Collections & Interiors Review, 2017.

ENDNOTES (cont.)

17. *Evaluating Immersive Experience*, 19.
18. *Evaluating Immersive Experience*, 7, 19, 37, 40.
19. *Evaluating Immersive Experience*, 20.
20. For these and other options, see *Immersive Content Formats for Future Audiences*, Limina Immersive for Digital Catapult, 2018, 5, 18, 26, 37, 40 and throughout.
21. S. Perry, M. Roussou, M. Economou, L. Pujol-Tost and H. Young, 'Moving Beyond the Virtual Museum: Engaging Visitors Emotionally', In: 23rd International Conference on Virtual Systems and Multimedia (VSMM 2018), Dublin, Ireland, 31 Oct - 04 Nov 2017, ISBN 9781538644959.
22. Perry et al. (2018)
23. *Immersive Content* (2018), 83.
24. Benedict Dellot and Brhmie Balaram, 'Machine Learning', *RSA Journal* 2018:3, 44-47 (46).
25. Lizzie Edwards and Juno Rae 'Creating a Virtual Bronze Age Roundhouse', *The Museum Blog Book* (2017), 421-27.
26. *The Burrell Collection Renaissance Project*, 2017.
27. *Evaluating Immersive Experience*, 25.
28. *Evaluating Immersive Experience*, 7, 25, 37-40.
29. *Evaluating Immersive Experience*, 2, 3, 5, 22.
30. *National Trust for Scotland Collections & Interiors Review* (2018)
31. *Immersive Content*, 84



University
of Glasgow

FURTHER DETAILS:

@scotimmersives

<http://bit.ly/scottish-heritage-partnership>

