

## Impact case study (REF3)

<b>Institution:</b> University of Nottingham		
<b>Unit of Assessment:</b> 11		
<b>Title of case study:</b> Innovating Cultural Products for the Creative Industries		
<b>Period when the underpinning research was undertaken:</b> 2000 to present		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Steve Benford	Professor of Computer Science	1988 to present
Chris Greenhalgh	Professor of Computer Science	1996 to present
Andy Crabtree	Professor of Computer Science	2002 to present
Paul Tennent	Assistant Professor	2007 to present
Martin Flintham	Assistant Professor	2007 to present
Joe Marshall	Assistant Professor	2008 to present
Boriana Koleva	Professor of Computer Science	1998 to present
Max Wilson	Associate Professor Human-Computer Interaction	2012 to present
Stuart Reeves	Assistant Professor	2010 to present
<b>Period when the claimed impact occurred:</b> August 2013 to December 2020		
<b>Is this case study continued from a case study submitted in 2014?</b> N		
<b>1. Summary of the impact</b>		
<p>Research by the Mixed Reality Lab, in the form of methods and techniques for enabling interactive cultural experience, has been used by artists and creative companies to develop new cultural products – performances, installations, films and museum experiences – that have toured to 84 venues in 16 countries, and been directly experienced by 87,000 people, and indirectly by millions more, to critical acclaim.</p> <p>Using the method of “performance-led research in the wild”, 20 creative companies, and more than 30 BAME artists supported by Talentlab, have engaged with our research in trajectories, uncomfortable interactions, visual-kinesthetic experiences, brain-computer interfaces, and hybrid gifting. Research has enabled the artists and companies to create work that is of higher quality, makes use of innovative technology, and reaches larger and broader international audiences. The cultural products have generated income and investment, built company or artist profile, and expanded the artist/company capacity to deliver future works. The approach has been embedded within national and regional research and knowledge transfer programs, and media companies including the BBC. We have sold over 1000 decks of ideation cards that enable others to apply our techniques to their own settings. Additionally, research has enabled work to be adapted to be experienced virtually during the lockdown because of the COVID-19 pandemic.</p>		
<b>2. Underpinning research</b>		
<p>The University of Nottingham’s Mixed Reality Lab (led by Professors Benford, Greenhalgh, Koleva and colleagues in the School of Computer Science) has, for over 20 years, led a programme of research that has developed new methods and techniques for enabling interactive cultural experience. The team has developed and applied the method of “performance-led research in the wild” [1]. This is a practice-led approach in which professional artists and researchers co-create touring cultural products including installations, performances and games. Research outputs, including new interface technologies and design concepts, emerge iteratively alongside the practice (rather than being the product of a linear pipeline).</p>		

All the impacts reported below directly exploited one or both of two overarching design frameworks that had emerged from research: the “trajectories conceptual framework” for designing audience journeys through mixed reality experiences [2] and the concept of “uncomfortable interactions” for designing compelling emotional experiences [3]. Both concepts were published in best papers (top 1% of submissions) at the prestigious ACM CHI conference. In terms of specific relationships between the cultural works reported below: Collishaw’s *Thresholds* directly builds on the notion of mixed reality boundaries and traversable interfaces as reported in [4]; Ramchurn’s two brain-controlled movies build on the brain-computer interface techniques reported in [5]; Walker’s *VR Playground* is an example of the approach of visual kinaesthetic experiences reported in [6]; and Blast Theory’s *GIFT* app directly implements the ideas of digital gift exchange [7]. The development of ideation cards as a way of disseminating design knowledge has been supported by underlying research into a digital cards platform for capturing data about card usage which then feeds back into their design [8].

The MRL’s method of “performance-led research in the wild” and the wider programme of underpinning research originated in the EPSRC-funded Equator Interdisciplinary Research Collaboration [9]. Impact was further expanded through collaboration with the successive iterations of the EPSRC Horizon Digital Economy Research Institute. The innovative nature of works delivered by Horizon’s Media Campaign, along with their public visibility, served to trail blaze new formats of data creativity for mainstream creative industries. The MRL refined the approach through a series of artist-led projects supported by the EPSRC Horizon Digital Economy Research Hub [10,11] and the associated Centres for Doctoral Training [12,13]. This experience led the MRL to establish an impact strategy based on a three-stage creative pipeline:

1. **Artist residencies** – fund creative partners to take up residency in our lab to build relationships, experiment with emerging technologies and seed new ideas for cultural products.
2. **Production projects** – take these new ideas through the production process as far as premiere performances to real audiences in recognised venues.
3. **Touring** – additional funds then transform the resulting cultural products into forms that can tour independently of the lab (i.e., without researchers having to go along with them) to maximise their audience and the potential for impact.

The success of this strategy in delivering impact alongside research has led to embedding of the pipeline into three major ongoing programmes [14,15,16].

### 3. References to the research

#### Publications

- [1] Benford, S., Greenhalgh, C., Crabtree, A., Flintham, M., Walker, B., Marshall, J., Koleva, B., Rennick Egglestone, S., Giannachi, G., Adams, M., Tandavanitj, N., and Row Farr, J., 2013. Performance-Led Research in the Wild. *ACM Transactions on Computer-Human Interaction*. 20, 3, Article 14 (July 2013), 22 pages. DOI: [10.1145/2491500.2491502](https://doi.org/10.1145/2491500.2491502)
- [2] Benford, S., Giannachi, G., Koleva, B., and Rodden, T., "From interaction to trajectories: designing coherent journeys through user experiences." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 709-718. ACM, 2009. (Best paper award, top 1% submissions) DOI: [10.1145/1518701.1518812](https://doi.org/10.1145/1518701.1518812)
- [3] Benford, S., Greenhalgh, C., Giannachi, G., Walker, B., Marshall, J., and Rodden, T., "Uncomfortable interactions." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 2005-2014. ACM, 2012. DOI: [10.1145/2207676.2208347](https://doi.org/10.1145/2207676.2208347)
- [4] Tennent, P., Martindale, S., Benford, S., Darzentas, D., Brundell, P. and Collishaw, M., 2020. *Thresholds: Embedding Virtual Reality in the Museum*. *ACM Journal on Computing and Cultural Heritage (JOCCH)*, 13(2), pp.1-35. DOI: [10.1145/3369394](https://doi.org/10.1145/3369394)
- [5] Pike, M., Ramchurn, R., Benford, S. and Wilson, M.L., 2016, May. #Scanners: Exploring the control of adaptive films using brain-computer interaction. In *Proceedings of the 2016*

CHI Conference on Human Factors in Computing Systems (pp. 5385-5396). Winner of Best Art paper Award. DOI: 10.1145/2858036.2858276

- [6] **Tennent P., Marshall J., Walker B., Brundell P., and Benford S.**, The challenges of Visual-Kinaesthetic experience. ACM Conference on Designing Interactive Systems, 10 June 2017, pp. 1265-1276. DOI:[10.1145/3064663.3064763](https://doi.org/10.1145/3064663.3064763)
- [7] Fosh, L., **Benford, S., Reeves, S. and Koleva, B.**, 2014, April. Gifting personal interpretations in galleries. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 625-634). DOI: 10.1145/2556288/2557259
- [8] Darzentas, D., Velt, R., Wetzell, R., Craigon, P.J., Wagner, H.G., Urquhart, L.D. and **Benford, S.**, 2019, May. Card mapper: enabling data-driven reflections on ideation cards. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (pp. 1-15). DOI: 10.1145/3290605.3300801

### Grants

- [9] Tom Rodden, Equator Technical Innovation in Physical and Digital Life, Interdisciplinary Research Collaboration, GR/N15986/01, EPSRC (2000-2008), GBP10.7M.
- [10] Derek McAuley, Horizon Digital Economy Research Hub, EP/G065802/1, EPSRC (2009-2015), GBP12.6M.
- [11] Derek McAuley, From Human Data to Personal Experience Horizon Digital Economy Research Hub, EP/M02315X/1, EPSRC (2015-2021), GBP4.1M.
- [12] Steven Benford, Ubiquitous Computing for a Digital Economy, EP/G037574/1, EPSRC (2009-2018), GBP5.7M
- [13] Steven Benford, Centre for Doctoral Training in My Life in Data, EP/L015463/1, EPSRC (2014-2023), GBP3M.
- [14] Boriana Koleva, Horizon: Trusted Data-Driven Products, EP/T022493/1, EPSRC (2020-2025), GBP4.1M.
- [15] Steven Benford, Centre for Doctoral Training in Horizon: Creating Our Lives in Data EP/S023305/1, EPSRC (2019-2028), GBP5.8M.
- [16] UKRI Trustworthy Autonomous Systems Hub, EP/V00784X/1, EPSRC (2020-2024), GBP12M. Steven Benford leads the Creative programme.

## 4. Details of the impact

### Co-creation of cultural products

The UK's Creative Industries employ over 3 million people, are growing at four times the rate of the economy as a whole and contributed GBP116 billion in Gross Value Added in 2019. "*They have been central to the UK's soft power, in driving tourism and exports, instrumental in bringing communities together and fundamental to the nation's mental health*" ([Creative Industries Federation, Spring Budget 2021](#)). The sector is dominated by small companies innovating new cultural products which then influence the mainstream formats delivered by global media companies.

The MRL has partnered with 20 of these small companies and individual practitioners within our creative pipeline, co-creating inspiring cultural products and touring them widely to attract mainstream attention. For each collaborator, the new products – performances, installations, films, and museum experiences – have generated income, built company or artist profile and expanded capacity to deliver future works **[A-F]**.

For example, the 20 year long [collaboration between MRL and Blast Theory](#), a Portslade-based artists' group, whose work mixes interactive media, digital broadcasting and live performance, delivered two successful apps: *Karen* and *GIFT*. The interactive game *Karen* has been downloaded and used by over 22,000 players since its release in 2015. *Karen's* release was covered by the New York Times and CNN, and the app has won multiple awards including 'Best of British Digital' at the 2015 British Interactive Media Association awards. *GIFT*, a webapp that enables museum visitors to create personalised tours as gifts for others, has been deployed by

museums in the UK, Norway, Germany and Serbia. Based on this work, Blast Theory (working in collaboration with the MRL) was awarded GBP100,000 from DCMS to develop a concept for the forthcoming national Festival UK 2022 [A].

Employing the technique of visual-kinesthetic experiences [6], and working in collaboration with the MRL, Brendan Walker created [VR Playground](#), a ride that overlays different virtual worlds on a physical swing. The work toured to festivals throughout the UK, the Victoria and Albert Museum, the Kimmel Centre, Philadelphia and the 2018 PyeongChang Olympiad in Korea and has been experienced by 30,000 riders. As a result of the work's reception, in 2018 Brendan launched a new company, [Studio Go Go](#) that provides interactive rides and VR experiences [E].

The MRL supported Matt Collishaw to develop [Thresholds](#), a room-scale 'superimposed reality' installation that premiered at Somerset House, London in 2017, before touring to other locations in the UK, and to France and Turkey, being experienced by over 10,000 participants. Matt explains, "*Alongside software development and technical innovations, key concepts from the MRL team were also instrumental in shaping the work... The team at the University was also instrumental in helping understand the audience experience through a combination of audience interviews, live observations and analysis of system log data gathered from over 5,000 participants that revealed patterns of movement and dwelling*" [B]. *Thresholds* received widespread media coverage (generating 59M social media impressions in Turkey alone) and was nominated for the prestigious Southbank Sky Arts Award in 2018. Matt is currently preparing a second new major in this oeuvre [B].

Horizon CDT student Roma Patel created [The Enchanted Forest](#), an interactive installation for children that was experienced by over 2,500 families during a six-month run at Hullabaloo Theatre (Hull). Roma explains, "*As a direct result of this success, I have since been invited to install commissions, deliver workshops and talks to creative practitioners including National Theatre (2020), nurseries in Great Yarmouth and Norwich (2017) and the Science of Learning Conference Durham (2019)*" [D]. Her spinout company, [Makers of Imaginary Worlds](#), established in 2020, has already won two Arts Council Awards and an EPSRC Telling tales of Engagement award to make further shows [D]. MRL research also enabled her works to continue to reach audiences in 2020. "*While face-to-face installations have been severely disrupted by COVID in 2020, we have successfully adapted to provide online storytelling workshops throughout October and December*" [D].

### Embedding concepts and methods

Lessons learned have been generalized into design concepts which have been disseminated through three further strategic activities: (i) the release of decks of [ideation cards](#); (ii) collaboration with the BBC; and (iii) a joint training programme with B3 Media targeting young Black, Asian and Minority Ethnic artists.

Ideation cards have emerged as a popular format for disseminating know-how to user experience designers in industry and researchers in academia, and also for engaging end-users in co-design. To date, 1250 decks of Mixed Reality Game design ideation cards have been distributed to industry and training partners. Museum networks Culture24 and Europeana helped run workshops with the Visitor Box museum deck with over 50 museums throughout Europe [G].

Research has been embedded at the BBC through a series of PhD internships, touring installations, and the provision of support for the organisation to develop their own deck of 'BBC Values' cards, "*as the basis of a new framework for measuring viewer experience of its output*" [H]. Head of Section, Future Experience Technologies explains how the broad variety of engagement has led to several impacts on the BBC including, "*the ability to take part in speculative research that delivers new ideas and technologies into the organisation; developing our staff; and expanding our teams through internship*" [H].

Researchers in the MRL have promoted diversity by partnering with B3 Media to deliver the Talentlab programme that trains young Black, Asian and Minority Ethnic artists in digital technologies. The MRL has provided bespoke support to over 30 film and digital artists through Talentlab, all of whom have gone on to make new works and win awards, with ten undertaking residencies in the MRL. Founder and Creative Director of B3 Media explains, “*The MRL offers ideas, technology and expertise enabling the artists to explore and produce artworks they otherwise wouldn’t have been able... The artists often have cutting edge complex ideas but lack the technical expertise to develop them, so the combination of MRL, the brilliant team of researchers, together with myself and B3 media allows us to realise these ideas creating some incredibly successful art pieces as well as developing the careers and onward opportunities for the artists*” [I]. During his residency, Richard Ramchurn created two [brain-controlled movies](#), touring them to venues in the UK, Iceland, Hong Kong and Italy. Richard explains how engaging with the MRL research led to improvements in the quality of his work, as well as enabling access to funding, technical support, and a broader audience, “*Nottingham’s pre-existing concepts of trajectories and uncomfortable interactions shaped the design of my films, while the studies of audience engagement led to new concepts such as ‘contesting control. Working with Steve and employing the performance-led research in the wild method provided the opportunity to study the interactions and responses with the audience, to react and improve the product – which is not something I could have done in the private sector*” [C].

In summary, research by the Mixed Reality Lab, has been used by artists and creative companies to develop new cultural products – performances, installations, films and museum experiences – that have toured to 84 venues in 16 countries, and been directly experienced by 87,000 people, and indirectly by millions more, to critical acclaim [J].

#### 5. Sources to corroborate the impact

- A. Interview with creative director of Blast Theory and webpages evidencing their artworks co-developed with UoN, including award winning Karen App and GIFT museum App [PDF]
- B. Interview with Matt Collishaw and evidence of co-produced artwork with UoN and impact of including ‘Thresholds’ and now creating ‘Bedlam’ (VR tech) [PDF]
- C. Interview with Richard Ramchurn and webpages to evidence the impact and reach of his artworks co-produced with UoN [PDF]
- D. Interview with Roma Patel, evidence of exhibits (reach) and creation of her new company via webpages [PDF]
- E. Interviews/ blogs with Brendan Walker detailing collaboration with UoN and evidence for his new company ‘Studio GoGo’ [PDF]
- F. Collection of evidence from further artists exhibits including, ‘Eye as a Witness’, Maria Kaliaomppa – Tour of Climb!, Rachel Jacobs – Prediction Machine series ‘Claire Twomey – Seen and Unseen’, ‘Jo Fairfax Conversation for Three’ and ‘Tom Dale – Digitopia’ [PDF]
- G. Webpage of Mixed reality game design cards <https://www.pervasiveplayground.com/mixed-reality-game-cards/> (accessed 10 February 2021) [PDF]
- H. Testimonial from Head of Section, Future Experience Technologies, BBC on impact of collaboration on key outputs including ‘Living room of the Future’ and Databox’, January 2021 [PDF]
- I. Testimonial from Founder of B3 media and webpages linking collaboration and impact on participating artists, January 2021 [PDF]
- J. Collated Exhibits (list of locations and audience size) in assessment period – on file.