EXPERIMENTS IN IMMERSION: LESSONS LEARNT FROM MIGRANTS TO MONSTERS

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ABSTRACT

In this paper, we will explore the insights that we have gathered from a dedicated immersive media research programme over 2015 –2016.

The BBC has over forty VR, 360 video and immersive audio experiments, that teams across the corporation have developed, covering a broad range of topics. We will look at three exemplary projects.

We will look in particular at the outcomes of research conducted during the creation, development, and deployment of the VR experiments, via dedicated primary market and audience research, as well as audience feedback at scale via the BBC Taster platform. We will draw conclusions from these findings and outline our future research ambitions.

INTRODUCTION

The BBC now has over forty 'immersive' projects – described as 'Pilots' – developed across the BBC's content production teams, informed by experimental research from BBC R&D, and published on the BBC's Taster platform. These pilots cover topics as broad as the migrant crisis, the Trooping of the Colour, and musical monsters. Three pilots exemplify our research approaches, around low barrier-to-entry (Web VR), experiences developed via gaming platforms and documentary-style 360 video intended for viewing via a VR headset.

1. Rome's Invisible City (ScanLAB - BBC Connected Studio, BBC History, 2016)

This pilot re-used LIDAR scanning data from the BBC television show *Rome's Invisible City* to create an experience that allowed you to explore ancient Rome in a photorealistic, but entirely computer-generated world.

Fig 1-Rome's Invisible City

Within the experience, users can move around a pre-defined route, allowing aspects of discovery and agency in controlling the narrative through gaze-based interaction.

The project was presented using an early version of Web GL and Web VR, and could be viewed on desktop or mobile where the experience could be controlled by click / tap and drag movements. Users could also use a Google Cardboard headset, which made use of gyroscope and stereoscopic VR presentation.

Available on BBC Taster: http://www.bbc.co.uk/taster/projects/romes-invisible-city-vr

2. We Wait (Aardman – BBC Connected Studio, BBC News, 2016)

This pilot created a computer-generated world that allowed participants to sit and travel with a family of migrants as they wait for a boat to cross the Mediterranean from Turkey to Greece.

The pilot initiated certain narrative aspects, by looking at characters in the experience to initiate dialogue or provoke a physical reaction. The pilot also used subtle embodiment, meaning that the viewer could look down in the experience and see their virtual 'body' as they looked around.

Technically, the pilot was built using the Unity game engine, and designed for Oculus Rift technology. Much of the design phase of this project was done using theatre set design techniques, and miniature scene creation, which then allowed the studio to build realistic 3D worlds in the Unity games engine.

Available on BBC Taster:
http://www.bbc.co.uk/taster/projects/we-wait

Figure 2 – We Wait

Figure 3 – Fire Rescue 360

3. *Fire Rescue 360* (BBC Connected Studio, 2016)

This pilot uses 360 video, designed for VR headset and headphones to create a hard-hitting reconstruction of what it is like to be a firefighter. It aims to provide as realistic a representation as possible, and explores aspects of factual storytelling that may be presented more effectively via 360 video as opposed to linear video. The pilot was produced to highlight the importance of 360 video in public service, and to explore a grammar of storytelling in 360 video for VR.

Available on BBC Taster: http://www.bbc.co.uk/taster/projects/fire-rescue-360

THE FRAMEWORK – FOR RESEARCH & EXPERIMENTATION:

A recent report by the EBU (EBU, 2017) concluded that although VR experiences have the potential to convey emotion, empathy and drive memorability, more needs to be done to understand these potential audience benefits, particularly given that the cost per hour for CG VR experiences is currently the same order of magnitude as high-end TV dramas.

Our strategy combines deep, speculative and fundamental research via BBC R&D, representative UK sample research developed in conjunction with BBC Marketing and Audiences, and scaled audience feedback via the BBC Taster platform.

	Fundamental Lab/Tech-Research	Production Notes	Controlled user studies & 'In-the-Wild' trials	Taster Open Trials
Research Description	Focussed detailed scientific research into core user experience and software applications of aspects of the technology. Often lab-based. In-house or in collaboration with academia or industrial partners.	Detailed write-ups and notes from producers and teams creating pilots. Including brief & treatment. Storyboarding, scripts, wireframes, code.	Semi-structured, controlled user studies with members of the public, run in conjunction with academic & external agency. Lab-based or 'in-the wild'.	Open trials. Pilots published onto the BBC Taster platform, allowing public access to experimental immersive content, and feedback.
Data Captured	User experience research & testing: qualitative data, quantitative data for stats. Small sample sizes. Bench testing & software trials. Technical data.	Notes on production techniques and pitfalls, Guidelines/information on the experience of practically developing pilots.	Quantitative and qualitative data based on surveys, observations, interviews. Sample size: 10s+ participants per pilot.	Ratings from 1 – 5 stars. Multiple choice survey answers. Behavioural website analytics, via Taster internal Analytics dashboard Sample size: 100s+ per pilot.

Fig. 4 - A framework of multiple research methods were used to derive maximum insight from BBC VR pilots.

For the pilots we are discussing in this paper, we were able to conduct multiple levels of research to build a picture of the impact and insight available from these experiments.

The process included:

1. Previous BBC **technical research** informed the approach to many of the immersive pilots, and in turn documented technical and user experience constraints apparent in these pilots.
2. **Production documentation methods** (applied as part of the Connected Studio programme) gathered evidence of the practical challenges inherent in developing content.
3. A controlled **user study programme** was designed to deliver a comparative evaluation of pilots across a series of metrics, focused on user experience, emotional impact, engagement, content consumption, and the content's ability to impart knowledge. Studies involve public participants in homes, in-the-wild, and in lab environments, assessed with the same survey and observation formats, with some nuance for specific questions. This allowed statistical quantitative analysis of the responses.
4. BBC Taster's unique feedback features provide visitors with the ability to rate pilots, and answer up to eight specific questions per pilot –which were aligned to the questions developed in the user studies. Every immersive pilot has detailed comparable feedback from diverse audiences exploring enjoyment, user experience, behaviour and impressions of pilots at scale.

RESEARCH FINDINGS:
In this section we will look at results from the individual pilots, and reveal findings from the different research methods.

1. *Rome's Invisible City*

The key strategic aims: to explore low barrier-to-entry (Web VR), and mass audiences.

Fundamental-research: Research into gaze-based interaction informed interaction choices in the project.

Production notes: A number of compatibility issues due to rapid evolution of WebVR, resulted in the production experiencing a number of setbacks. Using LIDAR was very effective at being able to portray spaces in high detail and render a comparatively lightweight 360 video through point-cloud data from the capture, minimising compute and data usage at the device level. The presentation on mobile phones, however, was limited by the resolution of the screen and the early stage of WebVR technology.

User Study: The gaze-based interaction method was considered a positive aspect to the pilot. It presented an effective means to offer navigation within an immersive experience. However, there were still a number of participants who did not notice the interactive elements. This was highly dependent on whether they used a headset or just their smartphone / computer. Participants saw *Rome's Invisible City* as highly memorable, and also as a content format that would provoke further investigation into the topic covered. Understanding of topic and immersion are improved by 10-20% when a participant is experiencing the pilot with a Google Cardboard headset as opposed to just using a smartphone or a computer. Similarly, headset usage had a significant positive impact on the understanding of how to navigate and observe the 3D world being presented.

BBC Taster: To date, close to 1000 respondents gave an average rating of 3.63 stars out of 5, marginally above average. Respondents to survey questions found the VR intriguing and were inspired to try more VR because of this.

Summary: The pilot itself has the capability to improve knowledge of the topic at hand above more traditional formats. Participants felt 'in' the experience, saying they had now visited ancient Rome. There are some challenges with developing and distributing scalable Web VR projects, but there are clear audience benefits in pursuing this method of developing content.

2. *We Wait*

The key strategic aims: to explore the use of gaming platforms (Unity) and high-end fully-immersive interactive experiences; VR documentary-making.

Fundamental-research: Immersive audio research was applied to inform audio choices in project.

Production notes: Well-established rules of documentary-making need to be revised and reviewed. For example, theatre techniques were employed to establish the viewer in the narrative, and to allow the viewer the freedom to explore the narrative in the way they wished. Photorealism was an objective that was unattainable, so cinematic lighting and

composition techniques, and stylised character animation, afforded freedom to focus on motion capture to ensure that character movement was as close to realistic as possible.

User study: *We Wait* scored highly in terms of originality and distinction, memorability, originality, and overall enjoyment metrics. Participants overwhelmingly felt this helped them to understand more about migrant issues. This deep connection between participants' sense of immersion and empathy, and understanding the issues covered, suggests that further VR projects would have success in using this technology to broach challenging topics.

The subtle level of interaction required to initiate the narrative, meant participants were often stuck at the start of the experience as they failed to 'interact' with the characters around them, by looking at them. They also did not notice their 'avatar' in the experience. The audio mix was a key driver for interaction, allowing participants to know where characters were, and where to look.

Format and technology were equal contributors to users' enjoyment of the pilot, suggesting there is some ambiguity to the drivers of enjoyment, given the emergent use of Oculus Rift device.

BBC Taster: To date over 1000 downloads of *We Wait* have resulted in an above average 3.74 stars out of 5. Low scores are partially attributed to not having the required technology to launch and experience the pilot. Respondents confirmed an empathic connection with the content, but only felt that they learnt 'a bit' about migrant issues. However they made a significant jump in understanding and knowledge of VR technology.

Summary: *We Wait* offers an entirely new experience of technology, and a highly engaging method for audiences to learn about pertinent issues. Although participants described the project as immersive and captivating, embodiment was not something that was explicitly noticed.

3. *Fire Rescue 360*

The key strategic aims: to explore 360 Video for VR & documentary making

Fundamental-Research: Guidelines on 360-filmic literacy and from attention studies were applied to inform directorial decisions.

User Study: An 'in-the-wild' study, through a collaboration with London Fire Brigade's Pop-up Museum [Museums and Heritage Advisor, 2016] has been set-up, allowing audiences to watch *Fire Rescue 360* via a headset and headphones. A fire engine set has been created for optimum viewing of the film – with low swivel stools to allow people to turn easily. The museum provides a useful way to try VR on an unexepectant audience. Data is gathered via questionnaires, semi-structured interviews and anecdotal observations at the museum as the installation is in progress.

Fig. 6 -. Fire Rescue 360 'in-the-wild' research at London Fire Brigade Museum.

35 responses to date unanimously rate the pilot 5/5 stars. People frequently were amazed and shocked after the film, and 97.2% of respondents mentioned they would use this technology to watch other films.

Suggestions for future use included additional effects such as smoke and smells to enhance the experience. Additionally there was discussion around how this kind of experience could be used for other types of incident such as road traffic accidents, or to show how equipment operated.

BBC Taster: 44% of respondents watched *Fire Rescue 360* on a desktop in a browser, 29% watched it on a mobile device most likely not in conjunction with a headset. These figures would suggest that publishers should currently take this into consideration when deciding where to publish VR films. Initial conclusions suggest 360 documentaries have potential to influence and inform audiences around challenging and hard-to-visualise topics.

Summary: *Fire Rescue 360* represents one of the first BBC experiments in 360 VR factual content creation. From a production perspective, the focus on quality and realism appears to have been successful in enhancing the capacity of 360 VR to provide informative, hard-hitting experiences in informational or educational topic areas. Creative attempts to get VR before audiences are necessary at a time when so few consumers have access to the technology.

KEY THEMES:

From a production perspective, simplicity, both for the end user, and the team creating the project is essential. Immersive formats are not yet mature, and as such, simple execution and clear user experience consideration are essential for success. This was particularly prevalent for *We Wait* and *Rome's Invisible City* which both employed interactive aspects to allow viewers to play a part in the narrative.

Considering audio as a primary means to control narrative and create interaction is also something that has appeared as a major driver in both Virtual Reality and 360 Video.

From an audience perspective, immersive content both increases engagement and retention of challenging subjects. Immersion and the positive effects of this use of technology are increased by appropriate choice of hardware. 360 Video and Web VR works well in desktop mode, but is enhanced by the use of a headset. Oculus Rift type experiences are the most immersive, memorable and engaging, because of the capacity for the technology to fully immerse the viewer in the experience. The primary drivers to the correlation between immersion and hardware adoption are the following:

- Larger field of view
- An improved fit to reduce light leakage and ensure accurate focus and positioning
- Higher resolution and computation power, resulting in lower latency for head movement, and crisper, higher contrast visuals.
- Improved audio

FUNDAMENTAL RESEARCH ON IMMERSIVE MEDIA:

On-going fundamental research, initiated by BBC R&D, has explored in detail how specific aspects of immersive content production and consumption can engage audiences.

Methods to **direct viewer's attention** have been investigated. We identified some basic

techniques taken from theatre, using movement and sound cues, and applied them (using different methods), to direct the viewer's attention to a new element of interest presented in the 360 video shot [Sheikh 2016]. A case study on how users adapt to **the grammar of storytelling in 360-degree video**, explored the effectiveness of different kinds of shots, the ability to look around, and the sense of presence afforded by immersive experiences, and how these affect the user's sense-making processes [Passmore 2017]. The ability to add subtitles to immersive 360 video is an important aspect of BBC accessibility work. We have researched how subtitles might be acceptably displayed within this context, namely to support the balance between comprehension, freedom to look around the scene, and immersion [Brown 2017]. **3D audio can be produced to enhance VR experiences**. This work highlighted how important audio can be, by converting audio originally created for an immersive audio drama and using as the basis for an animated children's story about a monster, *The Turning Forest* [Pike 2016]. Finally, **the effect of different viewing scenarios on the user experience** has also been investigated. Differences in user experience in terms of presence, attention, engagement, concentration on story, certainty, comfort and social ease can all be effected by device and context of viewing (be it linear VR content in a phone, a headset, or a CAVE-like projection system) [Passmore 2016; Philpot, 2017].

Collectively this research gives us an understanding of all aspects of the VR/360 production to consumption chain, covering production techniques, impact of viewing platform, and user behaviour.

ONGOING EXPLORATION & FUTURE PLANS:

The research we have conducted so far is directing how we develop future methodologies to better understand immersive technologies in the following areas:

Embodiment*:* As results from the study on *We Wait* were inconclusive regarding embodiment, the BBC is working closely with University College London to develop a longitudinal study around the effect of embodiment on user experience of immersive content. Isolating embodiment as a key driver of topic retention, or engagement / immersion requires further investigation over time.

Interaction: Extending the concept of embodiment, is the opportunity to take action or to gesture within an immersive experience, which builds on the high impact of being able to interact in projects like *We Wait* and *Rome's Invisible City*. Interaction (even as simple as a slight change in head position) is currently only possible with CGI VR, requiring games engine programming expertise. 360 video approaches are easier to use for producers from a non-games background, but interaction is currently either non-existent or limited to techniques such as branching narrative via gaze-based triggers. We are exploring approaches to bridging the gap between CGI and video, aiming for the realism of video and more advanced interactivity without needing games programming expertise, as well as light-field approaches to permitting head movement.

Barrier to entry: Many projects require an app to be downloaded, or a certain specification of smartphone or hardware to function. It is important to explore the capacity of Web VR and open platforms for the delivery of content. Similarly, the development of standards that allow for easier porting between development environments and technologies would make it easier for content to be deployed on multiple platforms.

Multi-format: The comparative benefits between immersive content and more linear or established digital formats needs exploring. The aim for this work is to more completely understand what aspects of immersive technologies, and other digital formats, are the right ones to deploy and invest in. We hope to have a clearer view on where immersive technologies sit within the wider BBC media mix as a result of this study.

Empathy, understanding, impact: Frequently, at all levels of the studies we have conducted, we notice participants stating that immersive formats are effective at communicating challenging topics, but there is some ambiguity around the long-term effectiveness once the novelty factor has worn off.

Feedback within experiences: Similarly, there is some limitation in the BBC Taster platform to consistently capture feedback within immersive experiences. This is especially where the experience is hosted or presented off the BBC platform. Because of this, there is on-going work to establish a means to easily capture feedback from within immersive experiences.

CONCLUSIONS

Virtual Reality experiences have proven significantly more difficult than originally anticipated, both in terms of production and distribution, but their impact is unprecedented in effectiveness at conveying a message and in immersion and emotional involvement in a narrative.

Within the 360 video arena, the experiments that have taken place have made it simple for teams across the BBC to draw on expertise and knowledge to ensure that the content they create is of a level of quality and uses techniques that ensures a certain level of success.

However, this period of experimentation has also highlighted the need for further research in the areas of interaction and embodiment, as well as the longer-term impact of adoption and the availability and access to technology.

Similarly, the methods used to evaluate content have evolved through this period of experimentation, resulting in the need for an understanding of the capability of immersive technologies compared with other content creation methods.

Immersive technologies are certainly part of the future of what the BBC and other media organisations invest in, but are still far from mainstream, with many production, hardware and audience challenges remaining to date, unanswered. The past two years has helped to provide answers to many of these challenges, has refined the ways in which the BBC invests in immersive technologies, and has set out a roadmap for ongoing research.

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