



Digital R&D Fund
for the Arts

Nottingham Castle: Riot 1831

**Learning and Engagement through the
Emergence of New Interactive Technologies**

Research & Development Report

Digital R&D Fund for the Arts

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Executive Summary

Background

Riot 1831@ Nottingham Castle is an augmented-reality (AR) permanent exhibition and app that places storytelling at its heart to connect audiences with a shared narrative. This report provides an overview and evaluation of a year-long digital-innovation project that was born out of a multidisciplinary collaboration between Nottingham City Museums & Galleries, Nottingham Trent University (School of Art and Design), Hot Knife Digital Media Ltd and University of Nottingham.

The project

The project evolved from a set of first-hand eyewitness accounts and museum objects in the Nottingham Castle collection that were a legacy of the riots in response to the rejection of the Reform Bill of 1831, which led to the burning of Nottingham Castle. These artefacts presented a dilemma about the notion of 'real history' and from whose perspective it should be told. Augmented reality combined with storytelling presented an opportunity for the museum to interpret these histories and help shift the balance between explicit information and implicit knowledge.

The mobile AR application used advanced object-tracking technology to superimpose 3D real-time computer environments and animated first-person 'performances' onto the museum objects. This allows visitors to simultaneously interact with the objects and experience the events that took place on the night of the riots

Results

The exhibition opened its doors to the public for the soft launch in May 2016 to coincide with Culture 24's festival, Museum at Night, with the app available only on the exhibition tablets. Over 200 visitors attended. By July 2016 the app was launched to the public, and in the three months that followed it was downloaded by 223 people, 62% using Apple devices. These figures do not reflect the total number of people using the app since the exhibition tablets are not monitored daily. According to the video ethnographic study, a minimum of 1230 visitors were considered 'engaged' with the exhibition tablets over a five-day period in peak season between 10am and 4pm. A high majority of these had a shared experience with two or more people using the tablets at the same time, in contrast to only 218 visitors using it alone. This suggests the flexibility of the tablets to accommodate group experiences and social interaction.

An integrated digital approach to AR, interwoven with the museum visitor's experience, encouraged discovery and learning and heightened engagement with the museum collection. A survey of 200 respondents revealed that 77% of visitors agreed that the use of AR was engaging, while 70% felt the app helped them to understand the historical relevance of the object and 79% felt the stories were very clear and helped them understand history; 85% agreed that they vividly remembered some part of the experience.

This approach permitted museum staff to observe the impact of AR on visitors and to see how the collaboration was helping to develop a more dynamic interpretation of the historical collection. However, it is important to highlight the considerable demands that are placed on

arts organisations in using emergent technologies. Finding the right solutions takes time and effort and this will inevitably have an impact on curatorial and exhibition staff time.

Insights

In multidisciplinary teams, time needs to be built into the schedule for partners to understand the constraints and benefits of the technology and the language of each partner's discipline.

Designing an exhibition around the needs of AR impacts significantly on the decision making of the curatorial and design processes.

AR places control in the hands of users. Active participation in discovering it is undoubtedly attractive and rewarding for users but the content needs to go beyond novelty and offer a meaningful experience.

When designing AR 3D animated scenes, you need to think about the relationship between the physical and digital environment since these will be simultaneously visible.

Designing interactive elements for AR brings its own set of challenges. The user interface should be clear, obvious and instinctive. Where possible, use visual clues and a minimum of supporting words.

Earlier usability testing of both the hardware and software in the exhibition space would have been beneficial, and a usability consultant would have made a valuable addition to the team.

Future

The employment of AR is challenging and can be expensive and disruptive to exhibition development, but it also offers unique opportunities as an interpretive medium. Using a theatrical, storytelling approach means AR can be designed to facilitate the moving body, alternative viewpoints and dramatic illusions, caused by the live camera incorporated with characters and short animated stories.

It is particularly suitable for museums and organisations with people-centred stories linked to their sites because it creates interactive dialogue between sound, visuals and the physical object or places in real time. It can increase dwell time as the content goes beyond the novelty and offers meaning and value to the visitor's experience.

For Hot Knife, the project has also opened up new market opportunities and income-revenue streams that have led the company to start selling the skills they've attained to new clients. They are investigating how the technology can be applied and further developed for the public and commercial sector, with a particular interest in the commercial use of AR in entertainment.

Background

Museum collections hold a wealth of information about historical events, but physical displays have a limited ability to help visitors understand the stories behind objects. Digital technology creates exciting opportunities to bring past events to life for visitors, and to deepen their engagement with historic sites.

The internationally relevant collections held by Nottingham City Museums & Galleries (NCMG) epitomise the significant and turbulent history of what is now a vibrant city. The museum has continued its role as a catalyst for new creativity since opening its doors in 1878, and is a major visitor destination in the East Midlands. It has developed a strong pedigree of creative programming and community participation, thus developing a range of networks for user testing and consultation.

NCMG had previously presented a film alongside some of these riot-related objects. However, the visitors did not make the connection between the stories in the film and the objects on display. Older 'book on the wall' exhibition areas catered for a declining audience and a more social and active experience was required to increase dwell time across generations. Like many heritage sites, the 'history offer' was passive and word-based, challenging for visitors to relate the presented information to the physical site. The richness of the legacy of this one pivotal night warranted more focused attention, requiring a new approach that was easy and instinctive and would appeal to a contemporary audience. Questions about the relationship between digital content and the physical design of an exhibition needed exploration, particularly whether the two elements could support each other in a coherent way rather than the digital element seeming like a temporary add-on.

A chance meeting between Adrian Davies (NCMG) and Roma Patel, Nottingham Trent University (NTU), in later kicked off some discussions about collaborating on a project about the riots. Around the same time, Hot Knife Digital Media was exploring the possibilities of app development. The Digital R&D Fund for the Arts presented the opportunity, and the University of Nottingham became the final partner to make up the interdisciplinary team. The project provided the partners with a space to work collaboratively, to bring their various skillsets and experiences together and to experiment with an innovative idea.

The AR medium

The aim of the R&D project was to deliver a site-based installation with an application and an exhibition. Augmented reality (AR) was a new medium for all partners, which had the potential to combine site, objects and people.

Nottingham Castle had identified an audience expectation for museums to bring people-centred history to life, and AR provided the technology to do this. AR required audiences to play an active role in the museum-going experience, placing control in their hands, and thus offered significant potential to enhance visitor's learning and enjoyment.

Current AR practice in museums

The Museum Associations 2015 mobile survey of 172 respondents confirmed that the sector was fully aware of the benefits of mobile technologies, since 50% of respondents already had a mobile offering and 67% saw it as a way of providing more content and engaging

experiences for their visitors. Of the different forms of mobile technology that were adopted, Quick Response (QR) codes (visual tags) were the most popular.

The multimedia capabilities of handheld devices and tablets are driving the advancement of optical tracking based on 3D object recognition and markerless AR, which could quickly surpass the use of QR codes in museums.

In 3D object recognition, the live camera on a mobile device scans the environment and recognises the physical object; it then overlays a combination of digital audio-visual content or text. With markerless application, labels or reference points are not required to activate the visualisations. The distance between the physical and conceptual is eliminated and the space, historical context and idea seamlessly come alive. Only a few museum projects have exploited the more interactive, dynamic and immersive elements of the medium for the purpose of storytelling.

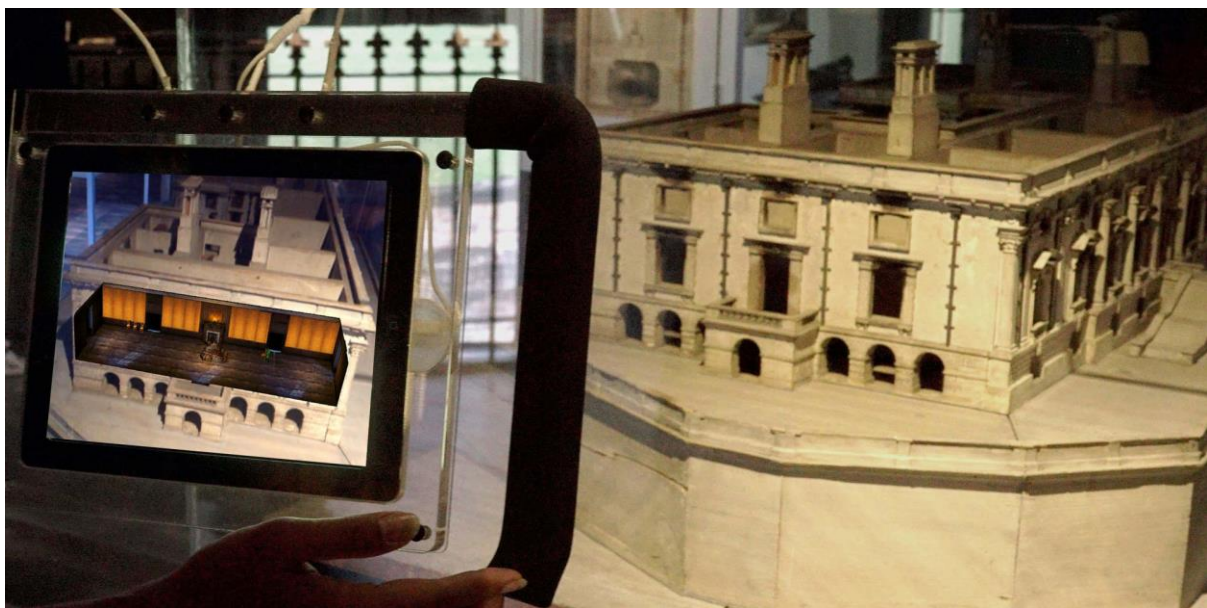


Figure 1: AR 3D real-time model overlay on a 3D scale model of the Ducal Palace at Nottingham Castle, presenting an opportunity to contextualise and bring to life the archive research of local historian Dr Trevor Foulds

AR content

In the last five years, several major museums have employed AR in their exhibitions. Most AR content has taken the form of information or games and has been more widely adopted in children's and science museums rather than in art and historical museums, possibly because of the difficulty of creating an experience that enhances an exhibition rather than distracts (Johnson, 2011). The British Museum's Gift for Athena (2013), which is a game-based AR app designed for Key Stage 2 children (ages 7-11 years) that uses object recognition, is a recent example. Storytelling, however, is accessible to a wider audience than games. In Riot 1831 the experiences are based on stories told by a cast of characters and the multiple perspectives of these historical characters offer several interpretations of the narrative that go beyond the institutional voice of authority.

Challenges and Opportunities

The major challenge for museums now is how to make the content more engaging and not simply to replace the labels that describe the objects with 'talking heads' essentially saying the same thing (McLean, 2010). Museums are competing with rich media content available to the public from the entertainment section and in many museums' content production has failed to keep up with technology' (Johnson, 2011). More imaginative approaches are needed.

Telling compelling stories about heritage objects can help deepen knowledge and entertain, allowing 'both the tangible and intangible to be explored simultaneously' (Johnson, 2006). However, this will require a change in how museums think. Stories are not just about objects and how they were made, but about 'people and their relationships' (Goins, 2014). A number of European-funded research consortia are exploring the areas of digital storytelling and AR interactivity in museums. CHESS (Cultural Heritage Experiences through Socio-personal Interactions and Storytelling) is developing an adaptive storytelling engine, and ArtSENSE project investigated adaptive AR using optical, transparent AR glasses.

AR in art

Museums can learn from the way in which artists are using AR to create mixed-reality experiences, explore the interplay between audience and site and produce interactive narratives and cinematic storytelling styles. Notable examples include:

- The Fantastic Flying Books of Morris (2013), the academy award-winning, animated short film from Moonbot Studios adapted as a printed book and accompanied by an AR 3D animated app
- Life in the 20th Century, 225 Million Murders (2011), an AR installation by Peter Weibel featuring a panoramic AR overlay on the physical environment that confronts the viewer with deaths caused by genocides, wars and murders
- 28 by Complex (2013), an AR cyber-noir film that uses film, montage and site-specific theatre to turn the urban environment into a canvas
- AR OCCUPY app (2011), an AR intervention by Occupy Wall Street.
- Into the Light (2019), an immersive audio installation brought together an interdisciplinary team of collaborators interested in using technology to play with sound in physical and virtual spaces.

The Riot 1831 research aims to bridge the gap between storytelling and the dynamic and performative elements of AR by exploring its potential as an artistic and interpretive medium within a museum context, drawing inspiration from the use of AR in artistic contexts.

The Project

Purpose

The overall research proposition was to investigate ways in which AR storytelling could add to the interpretive understanding of a heritage site. There were two key lines of enquiry:

1. How to create opportunities that allowed visitors to experience, connect and engage with an historical event by incorporating multiple perspectives.
2. To explore whether the relationships between digital and non-digital interpretation, the museum objects, heritage site and exhibition design were mutually supportive and could enhance the thematic content of the exhibition.

Objectives

The project was defined by five main objectives and research questions (see Table 1).

Research objectives	Research questions
1. To create interactive experiences that explore how augmented reality (AR) storytelling can become an interpretative technology.	What degree can AR storytelling distinctively add to the interpretive understanding of a heritage site?
2. To discover the properties of AR technology and how it can enable visitors to experience and engage with a more subjective history, that goes beyond the single voice of authority.	How can AR create opportunities to deepen the visitor's engagement and experience of an historical event through the use of multiple perspectives?
3. To discover how the physical and the virtual objects, interpretation and exhibition design can be mutually supportive.	What are the relationships between digital and non-digital interpretation, objects and site? Can they be mutually supportive and enhance the thematic content?
4. To explore how traditional narrative mediums like film and theatre can be used with AR and exhibition design to create a more cohesive narrative approach.	How can utilising film and theatrical techniques in AR create an integrated approach to narrative? Can it lead to a deeper understanding and enhance audience experience?
5. To understand the role that interactive real-time AR stories can play in encouraging the visitor to be more active, curious and get involved.	In what ways can audience participation and dwell time increase through their involvement in real-time AR interaction that encourages discovery and play?

Table 1: Research objectives and questions

Key steps and process

Initial concept and research

Riot 1831 was an ambitious undertaking within the timeframe. The early design process took an agile, practice-based approach, which enabled the creative team to start experimenting with AR and incorporate feedback from museum staff and the focus group from an early stage. A series of cross-disciplinary creative workshops led the creative team to establish the opportunities arising from the technology, the choice of objects and storylines. By the official start of the project, visual and historical research had begun and the outlines of the story arc, themes and many of the potential museum objects had been identified (see Figure 2).

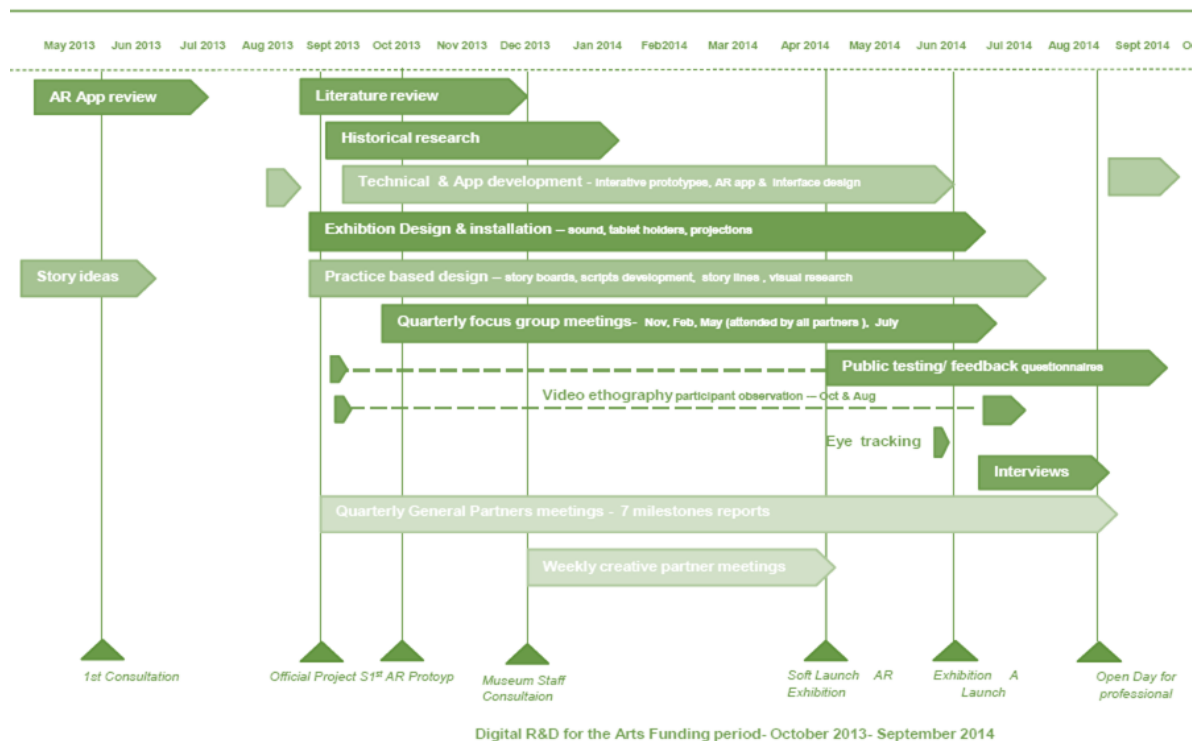


Figure 2: Project timeline including design process, technical development, key activities and research methods

Roles and responsibilities

Before the project the research partner knew the arts and technology partners, but the arts and technology partners were not acquainted. Even though all three lead partners were trained in art and design, exposure to the insights and challenges of each other's practices had a significant effect.

Content development

The first two months were spent exploring the storylines, researching the history and developing the scripts, storyboards and initial prototype. The team at Nottingham Castle collaborated with the art and design researchers to develop the storylines and AR interpretation. The aim was not just to adapt the events of the night of the riots in AR, but to understand the possibilities and constraints of a mixed-reality museum environment. As the storylines developed, the relationship between the AR medium and the museum object, and the telling of the story, became significant. The AR and interactive technologies were not always fully understood or clearly articulated. Early storyboarding suggested a static view of

AR and didn't account for users having control over their own viewing angles or duration of viewing a real-time 3D digital environment. For example, fixed close-ups were not possible. Spending time experiencing a wide range of existing AR apps helped the team understand the possibilities, and in the early stages of the story development the technology partner played the role of critical consultant.

Design and development

While the rest of the creative team concentrated on story development, Hot Knife researched the technical solutions, exploring the technical issues around object markers and object recognition, and testing the software platforms. Using historical and research documents provided by NCMG, Hot Knife designed and refined the digital assets, then based on the historical information and the script they moved into the animation and storytelling process in collaboration with the partners.

Prototyping

In order to test with focus groups, Hot Knife designed and built an early AR application prototype using physical reproductions of the museum objects. The first AR prototype (see Figure 6) was tested with a focus group. This played an important role in building confidence within the team about their approach of using real-time graphics and stories with AR. It also highlighted the challenge and the significance of designing an experience that attempted to go beyond novelty but was engaging enough to draw attention to the museum objects. One focus group member said:

'For me, it was the moment of moment of childlike playing! Amazingly, we put the phone in front of the picture and BANG it was there! The technology has so much potential'

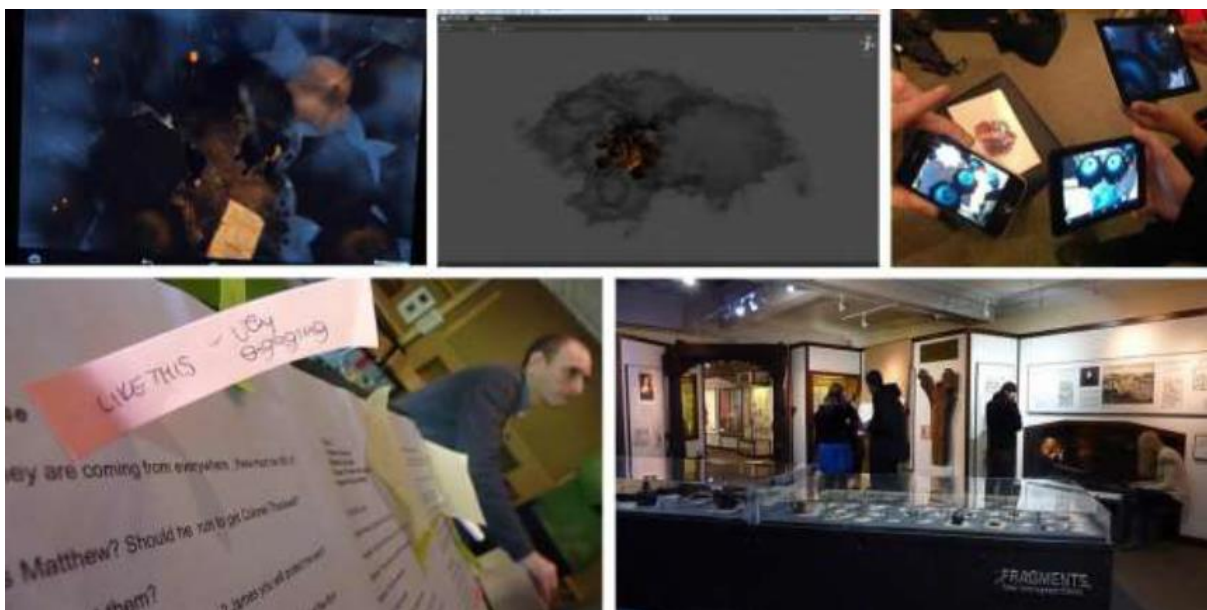


Figure 3: Focus group

The user interface (UI) and application user experience (UX) were designed and wire-framed, informed by feedback from the first round of testing. A second round of prototype testing was carried out in the gallery with actual museum objects.

Pilot

A pre-launched on 16 May. This delivered numerous technical and UX issues, which led to ongoing refinements. For example, UI information required extra instructions, i.e. icon plus word. The non-linear approach concerned visitors, partners and museum staff, prompting the team to install a visual timeline of the story at the two main entrances and to design the AR app menu in chronological order to provide some guidance to visitors with their own mobile devices. The length of any audio within the app was cut wherever possible.

Official release

The first release of the app for iOS and Android (1.0) entered the stores for public launch on 4 July 2016, to coincide with the formal exhibition launch. As before, there were numerous technical and UX issues with refinements ongoing.

Research methodology

The research took a mixed-method approach since it involved academics and practitioners from different subject areas: art and design, history and computer science, exhibition design and animation.

- A practice-based design enabled exploration and artistic experimentation with the AR medium. The art and design researchers had experience of adapting technology within their traditional theatre and film practice and previous experience working with local museums. This was useful in the early stages since the team from NCMG had little experience of digital technologies
- Qualitative data research was conducted to gain an in-depth understanding of the needs and experiences of museum visitors and staff. This included focus groups, participant observation, video ethnography and interviews
- Quantitative research, in the form of a survey, was carried out in an effort to understand the experiences of a wider cross section of museum visitors.

Marketing

The marketing plan was based on existing communication channels for a cost-effective approach. Nottingham City Council and NTU marketing teams worked together to develop a project profile. The soft launch put pressure on both partners, but the public testing highlighted many issues. The formal launch was timed to hit the peak summer season, avoiding other programmed exhibition launches and changeovers on site.

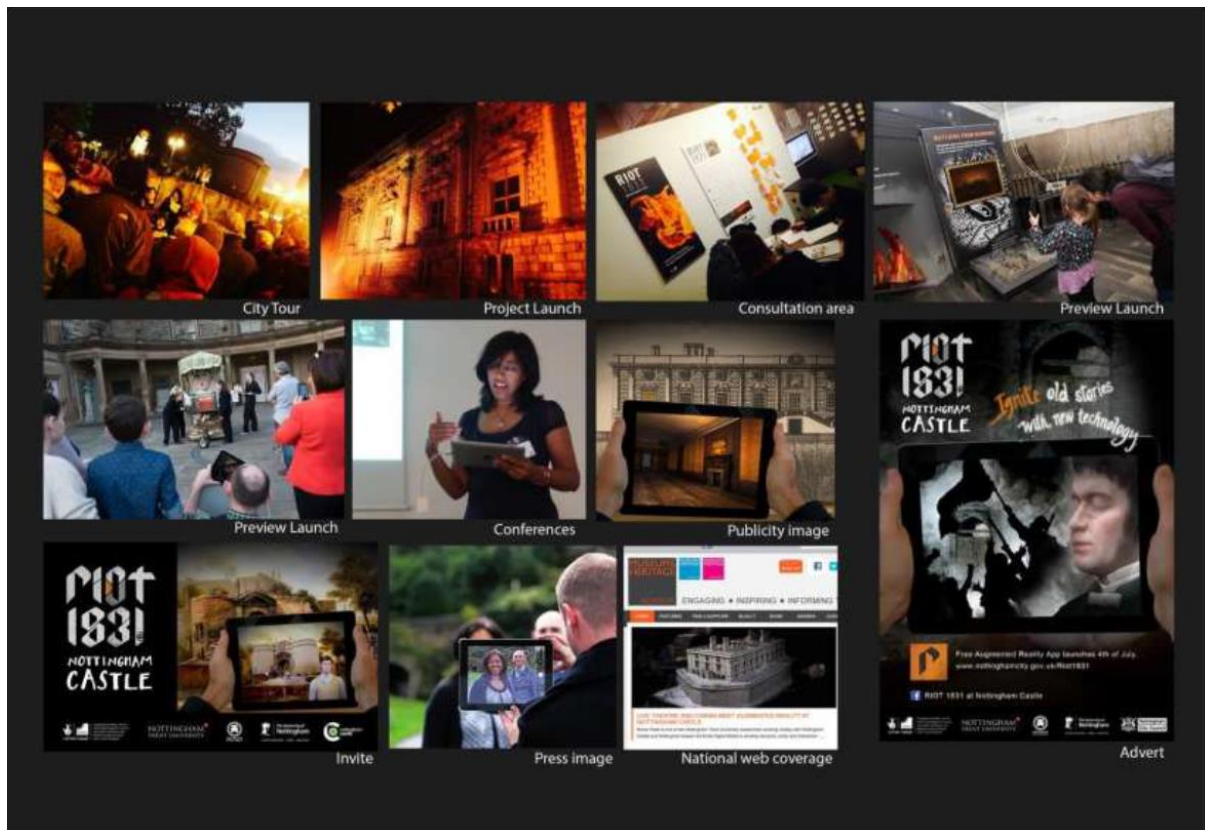


Figure 4. Marketing and communication images

Risk

Although many risks were mitigated from the outset, the following risks materialised:

- Delays with contracts led to delays in payments to partners
- Procurement issues on account of lack of information from funders concerning the arts organisation as the financial centre of the project
- User interface design was not costed
- Script development took longer than anticipated
- Audio production was vastly underestimated and became a project in its own right
- General insufficient project support for the scale and complexity, including project manager, public relations officer, digital producer, writers, administrators for launches and open day
- The project was overly ambitious and generally the work snowballed.

These risks were mitigated by the goodwill of the partners and strong personal commitment to the project development, in-kind support from all, some re-allocation of the project fund and the sourcing of extra funds.

Resources

The project took over two years to develop from initial concept, including the time spent on applying for the Digital R&D Fund. It involved significant input from the core creative team for

a period of 18 months, and concentrated input over a period of 12 months. A request was put in for the funding to be delayed in order to cover the team for the 12 months of intense work.

Digital R&D Fund (£125,000)

Combined research team (including conference, learning events and travel)	£33,500
Technology partner (including Metaio SDK, Unity, data analytics, UI design)	£61,500
Freelance project support – sound, graphics, actors	£17,000
Equipment tablets and some materials	£10,500
Consultation focus groups, open day and consumables	£2,500

Additional Funds

NCMG design budget (exhibition)	£10,500
ACE digital development (ongoing digital spin-off installations, project Facebook page, additional audio production, digital archive support)	£27,000

Museum service staff time was all in-kind £100,000 (estimated)

Table 2: Budget

Project outputs

-AR exhibition

The AR exhibition was designed as a self-guided experience to allow for discovery and exploration. To enable everybody to access the works, tablets are available for public use. These are encased in clear Perspex and tethered to the ceiling to hang down in front of the designated exhibits. Free Wi-Fi is available in the museum space so the application can be downloaded on site.

The exhibition space was designed so that the atmosphere would take on an active role: the space is dark and dramatic; the walls are painted grey; the sound of rioters echoes throughout the space and projections of contemporary riots slowly emerge onto a rough concrete wall; a large touchscreen book is embedded in a desk, lighting up to reveal excerpts from the Duke of Newcastle's diary; the chalk scrawled words of the visitors are etched onto a blackboard.

The five AR stories follow a sequence of linear events with a beginning, middle and end. The first story takes place on the night the news of the Reform Bill reaches Nottingham, and the final story is 48 hours later when the Ducal Palace is on fire. However, since the exhibition space has multiple entrances (see Figure 5), the visitor does not necessarily experience the stories in chronological order.

Initially, little guidance was offered to visitors about how to interpret the stories, partly prompted by research demonstrating how people create connections and make sense of stories by bringing their past experiences to making inferences (Haven, 2013). Instead, visitors were left to interpret the stories and their connection to the event in order to create their own meaning. However, this lack of information and the non-linear approach concerned visitors, partners and museum staff, prompting the team to install a visual timeline of the story at the two main entrances, and to design the AR app menu in chronological order to provide some guidance to visitors with their own mobile devices.

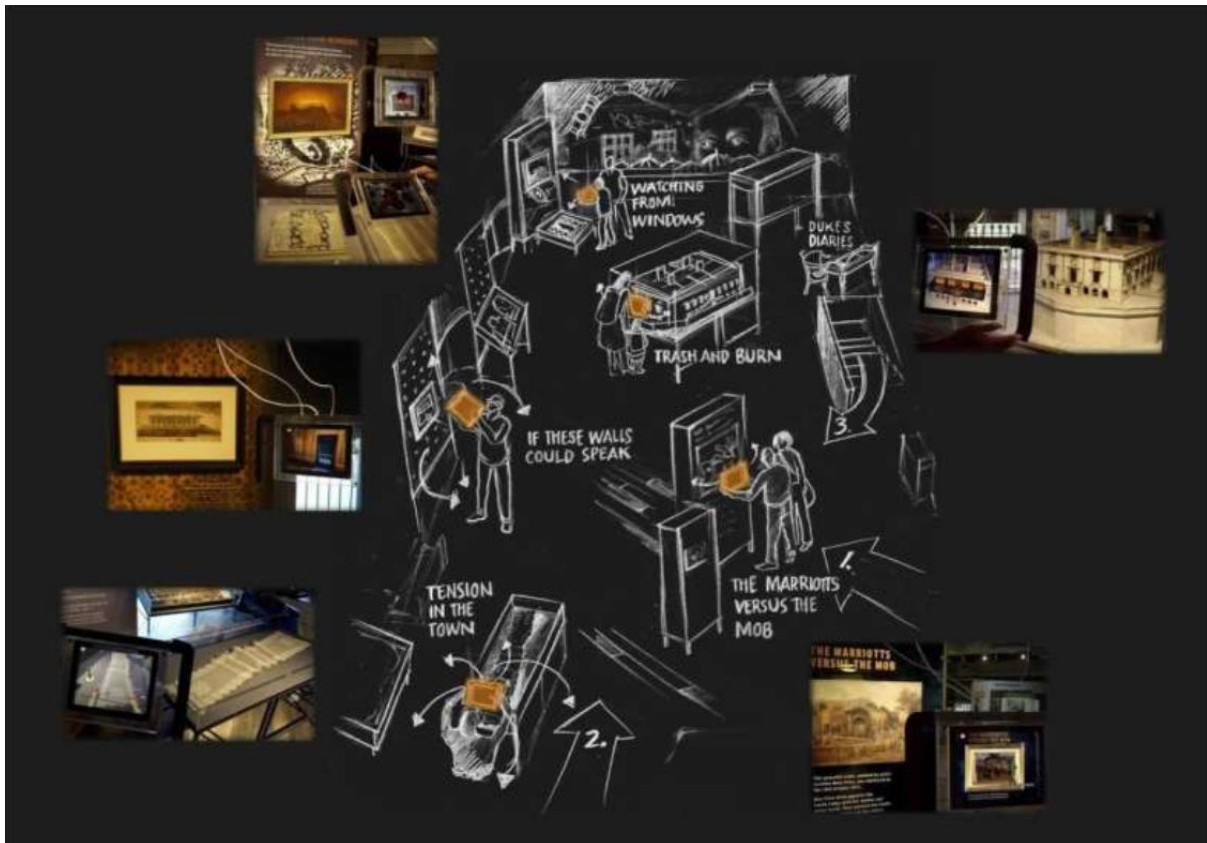


Figure 5: Illustration of AR exhibition layout

-AR mobile app

The mobile app is a bespoke cross-platform application for augmenting narrative storylines over museum objects. Two versions were built: a gallery version that was uploaded directly from laptop to gallery devices, and a public version available to download from app stores. Both versions were required because of the constraints on gallery tablets. These were tethered for security and practical issues, which meant that the gallery version was designed to be restricted to the museum object, whereas the public version was designed to enable users to move freely around the gallery using their own devices.

-AR mobile-app content

Staging the AR stories

It was crucial to the interpretation of the stories that they were told from a first-person point of view so that the main character was the narrator of his/her story and the visitor a witness. Five separate AR experiences were created for the exhibition and one for use at home (see Figure 6-10).

The challenge was to get the balance right between the creative aspirations of the storytelling and the optimisation of the digital assets for a mobile screen. The creative team went for a non-realistic approach, using minimal props accompanied by special effects and sound. Sometimes characters were heard but not seen.

The team deliberately selected different types of museum object to explore the capabilities of object recognition. The final list included a lace scarf, digital print, tapestry, wooden scale model, oil painting and etching (Figure 6-10).

The length of the stories was restricted in response to limited visitor attention span and fatigue in large heritage sites with concurrent exhibitions, with a more interactive approach used to engage visitors. The physical act of moving the mobile-device camera in front, over, above and around an object caused the narrative to unravel and characters to be revealed.

Two of the stories use real-time panoramic augmentation, which renders the alignment of the museum object unnecessary once the visitor has 'triggered' the alignment of the content. The visitor can move the device 360 degrees and remain surrounded by an unbroken view of animated images and text layered over the live-camera view of the gallery (Figure 11-15). Using this technique, the narrative and the site become inseparable (see Appendix 1 for more details).


Story Title		Tension in the Town	
Museum Object			
Type	Lace Scarf		
Setting	House in the Town & the City		
Story	Working class family life, News of the Reform bill, the rioters gather on the city streets.	Facts-	about life in 1830's Nottingham
Object Tracking	Dependent	Non-dependent	
AR Scene (Animation & Props)	Boy's hand, tool and lace threads	Lace images and threads formations animated in space	
Tablet Live Camera Movement (Mobile)	Single shot Follow shot	Panorama (360 degrees) augmented in the gallery space	
Staging (Theatre)	In the Round		
Shots (Film)	Medium close up POV (point of view) of the little boy	Voice-over	
Interaction (on Screen)	Touch and drag threads to progress the story into the city		
Characters Journey	John (close up hand) John's Mother (voice) Rioters (voice)		

Figure 6: AR story_ Tension in the Town, based on the lace scarf


Story Title	
The Marriotts v the Mob	
Museum Object	
Type	Digital Print (Oil Painting)
Setting	Outside the Castle Gate House
Story	James Marriott, the gatehouse keeper recounts his experience (a year later) in a Courtroom of the rioters gathering outside the Castle in violent civil disorder.
Object Tracking	Dependent
AR Scene (Animation & Props)	3D Animation of James Marriot
Tablet Live Camera Movement (Mobile)	180 degrees around AR scene camera angle-high, low tilt Move forward to zoom in
Staging (Theatre)	Thrust Toy theatre Fade (characters)
Shots (Film)	Full shot Flashback Continuous cut Subjective camera
Interaction (on Screen)	Touch screen to hear rioters conversations
Characters Journey	John (silhouette) Rioters (silhouette) Mr Marriott (3D animation) Mrs Marriott (voice)

Figure 7: AR story_ The Marriott's v the Mob, based on the oil painting


Story Title If these walls could speak	
Museum Object	
Type	Etching
Setting	Long Gallery walkthrough
Story	Story of the Long Gallery from 16 th century to the demise of the site. The rioters have entered the grounds.
Object Tracking	Non-dependent
AR Scene (Animation & Props)	The Long Gallery with some furniture. Special effects – dust in the air and atmospheric lighting.
Tablet Live Camera Movement (Mobile)	Panorama 360 VR Camera angle-high, low tilt
Staging (Theatre)	Promenade
Shorts (Film)	Pan shot Voice-over
Interaction (on Screen)	
Characters Journey	Tour Guide (voice) Rioters (voice)

Figure 8: AR story_ If these walls could speak, based on the etching of the Nottingham Castle


Story Title		Trash and Burn
Museum Object		
Type	3D Scale Model	
Setting	Long Gallery balcony & inside	
Story	The rioters entered the Long Gallery and start piling up furniture for a fire – they set the room alight and leave with rich pickings.	
Object Tracking	Dependent	
AR Scene (Animation & Props)	Balcony	The Long Gallery room with furniture piled up, candles, tapestry, three animated characters
Tablet Live Camera Movement (Mobile)	Single shot Move toward to Zoom in	
Staging (Theatre)	Proscenium stage – three walled box set	
Shorts (Film)		
Interaction (on Screen)	Touch and drag the chain to progress the story into the city	
Characters Journey	3 Rioter (3D animation) John (shadow)	

Figure 9: AR story_ Trash and Burn, based on the 3D scaled model of the Nottingham Castle


Story Title		Watching from the Window	
Museum Object			
Type	Oil Painting	Tapestry	
Setting	View of the Castle from a young girl's window		
Story	Mrs Gilbert's eyewitness account of the Castle on fire	Mrs Gilbert – rioters sell the tapestry outside the Castle	Mother's song for her dead son the day after the fire
Object Tracking	Dependent	Dependent	Non-dependent
AR Scene (Animation & Props)	Rain, smoke, meeting poster	Umbrellas, people, rioter, tapestry, meeting poster	Smoke, ambers in exhibition space
Tablet Live Camera Movement (Mobile)	Single shot Camera angle-high, low tilt	Pan down camera angel-high, low tilt Move forward to zoom in	Panorama (360 degrees) augmented in the gallery space
Staging (Theatre)	In the Round		
Shorts (Film)	Long shot Bridging shot Subjective camera	High angle shot Subjective camera (POV)	
Interaction (on Screen)			
Characters Journey	1 Rioter (voice) Mrs Gilbert (voice)	John (song) John's mother (singing)	

Figure 10: AR story_ Watching from the window, based on the oil painting of the night and the original tapestry

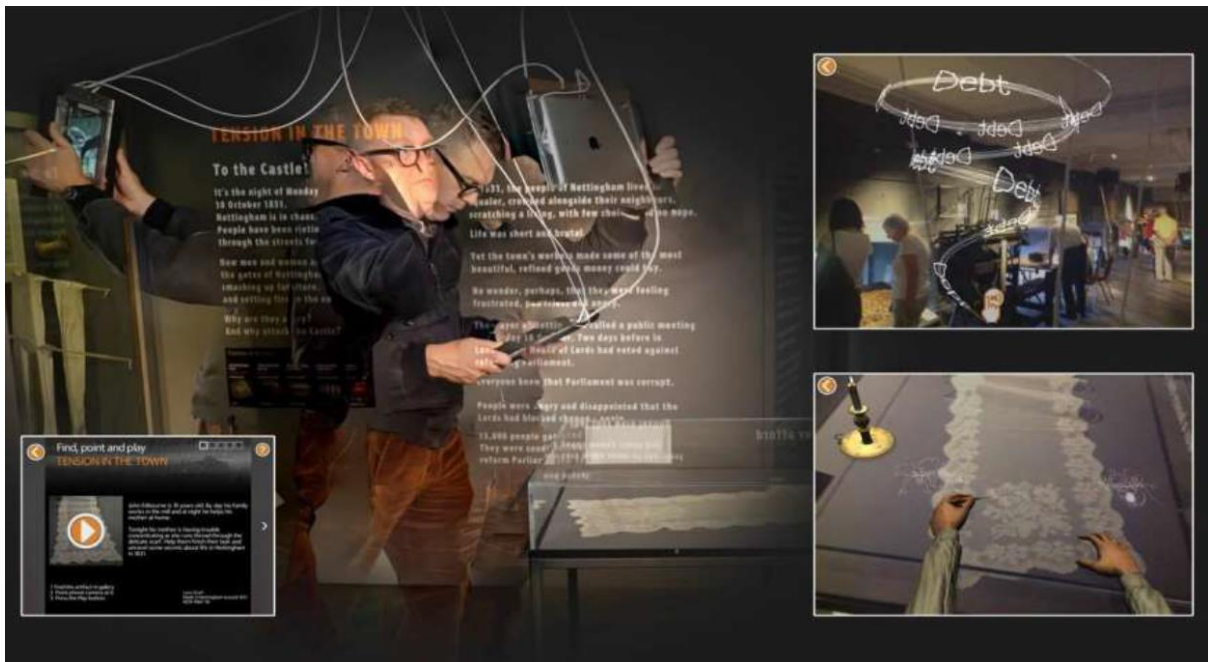


Figure 11: TENSION IN THE TOWN / The first animation in the sequence was designed to augment a lace scarf in the museum's collection. It introduces the story of the riots from the point of view of a young boy as he helps his mother to unpick her misplaced stitches as she makes the lace scarf.



Figure 12: THE MARRIOTT'S VERSUS THE MOB / Designed to augment a painting of the castle lodge, the animation tells the story of James Marriott, the castle lodge keeper and his wife, as they react to the mob's attack. The narrative is taken from James Marriott's testimony in court in 1832.

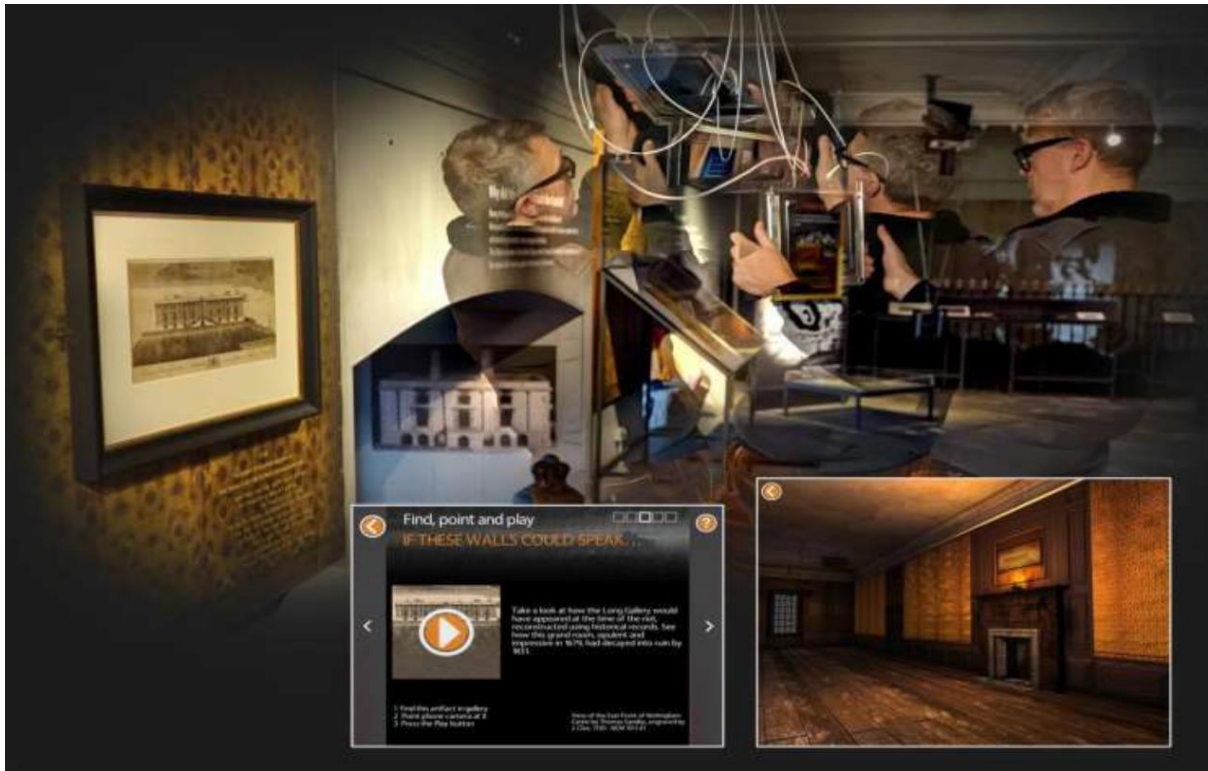


Figure 13: IF These walls could speak... /This animation augments an etching of castle in order to reveal how the Long Gallery would have appeared just before the rioters entered. A 3D panoramic triggered by the etching provides a virtual-reality experience where the user can move the device around 360 degrees

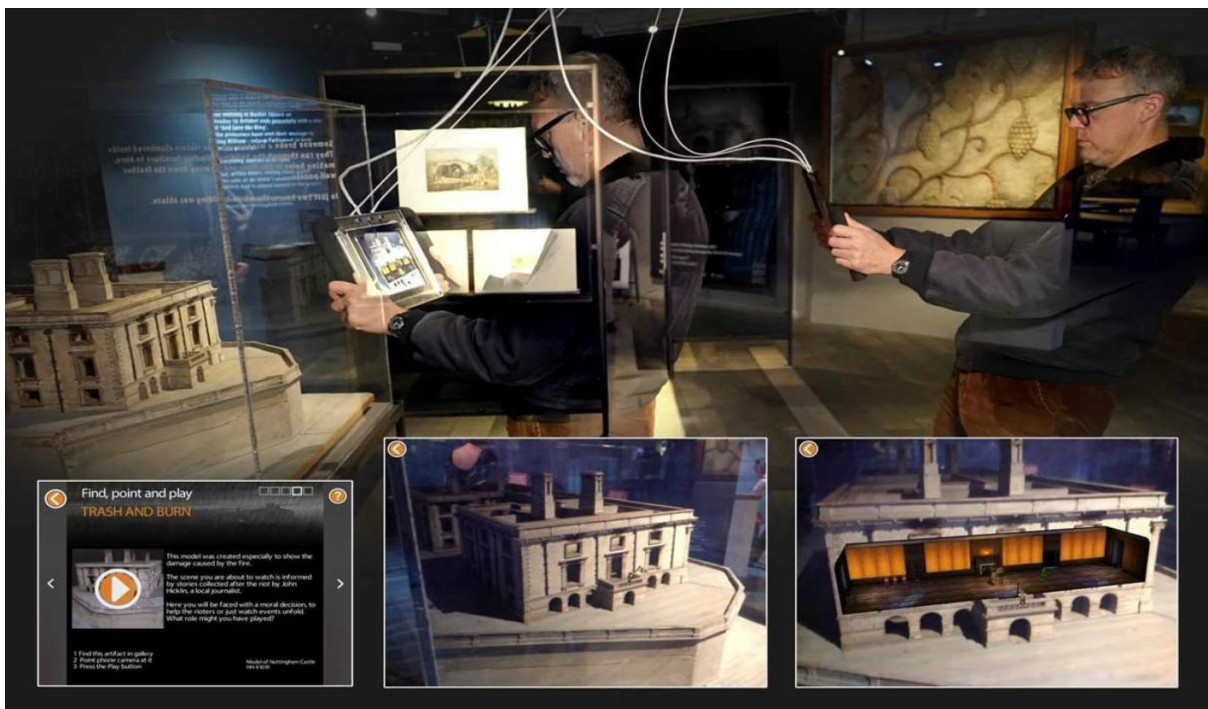


Figure 14: TRASH AND BURN / A 3D model of Nottingham Castle made in 1832 is augmented with an animation showing the inside of the Long Gallery. The narrative reveals the lead rioter's antipathy to the aristocracy and the user is invited to collude with him by helping to burn down the gallery.



Figure 15: WATCHING FROM WINDOWS / A dramatic oil painting showing the castle in flames is augmented with fire and smoke effects. The narrative is based on the account of a young girl who watched a crowd gather below her window to sell fragments of tapestry from the castle at three shillings a yard. The crowd is represented using an animation of jostling umbrellas viewed from above

Script

Museum audiences expect fact, not fiction, so it was originally envisaged that 95% of the script would be historical quotes. As the project developed it became apparent that to create empathy with the characters, build dramatic tension and expand the possibilities of the AR experience, new scripts would be needed. The scripts had to be re-edited to suit the budget and time restraints so the scriptwriting process was prolonged, which in hindsight posed a risk.

Sound

The sound design played a pivotal role in setting the AR scene and evoking the atmosphere of the exhibition, much like in film or theatre. At some points the sound implied meaning, at other times it created the setting and sometimes it supported the text. Examples range from creaking doors and footsteps on the floor of the Long Gallery, a young boy addressing the visitor, the chanting of hundreds of rioters about to attack the castle, or the sound of the fire crackling as the castle burned.

Interaction

Some of the stories have on-screen interactions where the visitor can participate by helping a character fulfil their goal or progress through the story. One visitor said:

'The interactive elements the way you tapped on the screen to move the furniture into the burning fire or helped the lace person out were really clever. I loved it and I'm sure everyone under my age group would love it, and I'm sure most of the older generation would also love to have a go.' (See Figure 16)

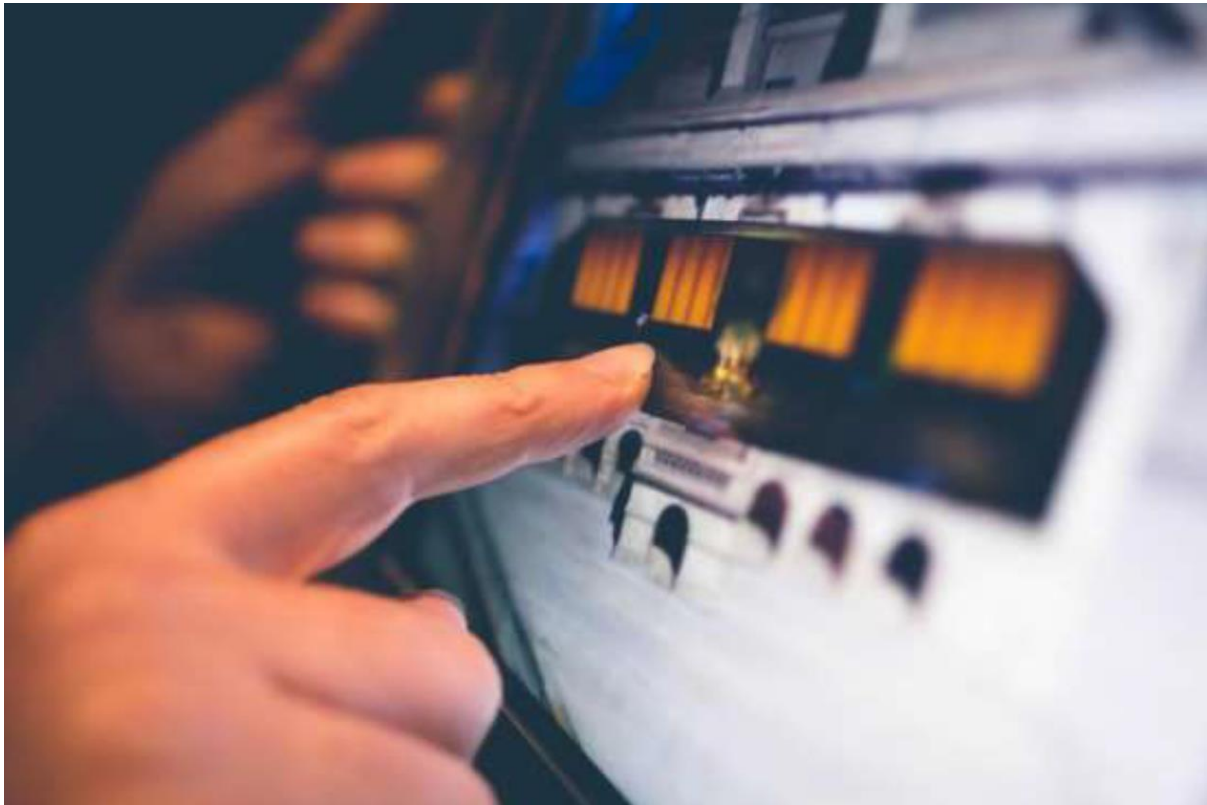


Figure 16: 'Trash and Burn' visitor moving furniture onto fire

User interface

User testing led to some interesting discoveries about user interfaces for AR. For example, in 'Tension in the Town' a boy points to a lace thread and invites the user to pull it. The call to action was embedded within the boy's narrative but many visitors didn't understand it, leading the team to conclude that augmented reality did not yet have a recognisable user interface. A graphical user interface with a new set of icons to illustrate the interactions was designed by the technology partner in response to this feedback (see Figures 17).

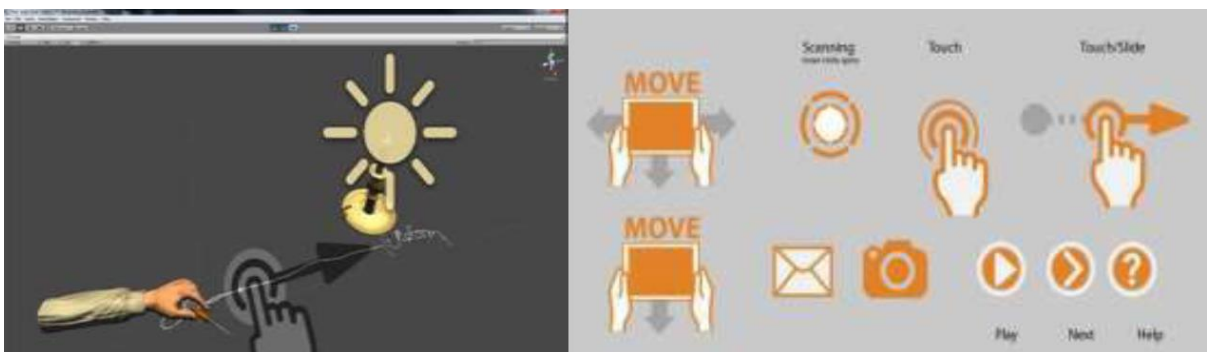


Figure 17: Icon design for pulling the thread and App icons.

The following section captures the process of creating the 3D animations, AR experiences and the technical outputs of these processes.

3D animation

High-resolution 3D assets were built using Zbrush and Photoshop for the materials and textures, and 3D Studio Max to animate the characters (Figure 18). The digital assets were created in high resolution, and then low-resolution versions that would still retain the detail of the high-res models but would run on a phone. The models were rigged, a process that involves putting a digital skeleton inside a mesh so that it can be animated. Unity 3D, a games authoring package, was used to bring all the assets together and publish the app, enabling Hot Knife to author the animations as a game.



Figure 18: 3D animation of James Marriott at different stages of development

Augmented reality

Metaio provided the AR tracking functionality via 2D image recognition, 3D object recognition and triggering. Basic programming was performed using a drag-and-drop interface in the authoring package. Hot Knife developed their own tool to improve the alignment of 3D objects

to their markers, enabling them to achieve the accuracy required to position the digital assets exactly to the real-world objects.

Alternative formats

AR in conjunction with a real-time 3D environment limited the incorporation of subtitles or a video of British sign language (BSL) signers. To make the interactive content more accessible, it was captured on video and edited with subtitles, with BSL signers filmed behind 'green screen'. The video will be available in the exhibition space. The accessibility advisor, a member of the project focus group, was key in helping develop this resource. For visually impaired or blind visitors, the audio description charity VocalEyes worked with NCMG to produce two audio descriptions of the project, available for download at Nottingham Castle website. The audio descriptions combine dialogue and soundscapes from AR-animated scenes, visual descriptions of the marker objects, extensive contextual historical information and directions for orientation around the site of the exhibition. Both these initiatives illustrate how existing digital content can be re-used and re-formatted to reach audiences with particular needs.

Results

The integration of AR technologies as an interpretative storytelling medium, combined with traditional museum practices, helped to evoke the past, making the objects more accessible and engaging. It was not a distraction as the museum object remains central to the display. The position of the tablets disrupted the 'normal' of the exhibition space and offered an entry point to those who may not normally engage with technology or the collection. It invited museum visitors to engage proactively in their own learning and experience.

Overall, the sharing of ideas through joint exploration emphasised to the partners the value of in-depth collaboration outside of their practice communities. The constraints and affordances of tablets in combination with emergent AR and real-time 3D technologies were more demanding and time-consuming, leading to compromises in both artistic and aesthetic interpretation. However, it was not always about the use of current technology, but the ways in which it can be integrated to enhance dialogue and interactivity with the collection.

Key outcomes

- The exhibition opened its doors to the public for the soft launch to coincide with Culture 24's festival, Museum at Night. Over 200 visitors attended the soft launch. The app was only available on the exhibition tablets
- The app launched to the public and in the three months that followed was downloaded by 223 people, 62% using Apple devices. These figures do not reflect the total number of people using the app since the exhibition tablets are not monitored daily. An indication of their use is derived from the video ethnographic study
- The results from the visitors' questionnaire, testing with focus groups, feedback and expert opinion indicate that the AR interpretation and storytelling approach were successful in creating a more engaging exhibition, which added to the museum experience rather than distracting from the museum object.
- 'I just think what the future of an exhibition would be like, more interactive and more interesting than just walking around seeing things in a glass case. It gets you involved with the exhibit. I like that, especially as my purpose is focused purely on the disabled side of things. For disabled people I think it would be more interesting and a lot more interactive for them.' (Focus group member)
- According to the video ethnographic study, a minimum of 1,230 visitors were considered with the exhibition tablets over a five-day period in peak season, between 10.00am and 4.00pm. A high majority of these observed visitors had a shared experience, with two or more people using the tablets at the same time, in contrast to only 218 visitors using it alone. This suggests the flexibility of the tablets to accommodate group experiences and social interaction.

A visitor is considered to be 'engaged' with an exhibit if they are visibly attending to and/or bodily interacting with it in some way (including being part of a group or pair that is around the

exhibit). Occasional 'glances' are not considered as engagement, except in extreme cases where a visitor spends a prolonged period of time looking at the tablet in question.

Observing the visitor video ethnographic study

The video ethnography study reveals interesting insights into the challenges and solution of designing AR experiences.

Most visitors understood immediately that augmented reality was an interactional matter, i.e. those who used the tablets did not display any observable indications of misunderstanding the principles by which AR works.

Lesson: If designed carefully, AR exhibits are not or but readily comprehensible for the average visitor to engage with in a meaningful way.

AR

The study revealed a delicate balance between the need for immediacy and the potential for exploration. The tablets had to support rapid engagement and quick delivery of content, but also take advantage of the primary value offered by AR for exploring by pointing the tablets at exhibition objects. Compounding this, the multiple entrances to the exhibition space mean that visitors can approach in three distinct ways. The balance between immediacy and exploration favours placing more complex exploratory exhibits 'deeper' into the exhibition. However, this may conflict with the attempt to organise a narrative sequence for visitors as they move between the tablets.

Lesson: Exploration is often offered at the expense of immediacy for the visitor.

For exhibits with simpler design, such as 'The Marriotts versus the Mob', and 'Trash and Burn', access to the AR content was achieved with a small amount of effort and was followed through by most visitors. These simple designs were achieved by offering clearly 'pre-aligned' content and limited objects to augment. Exhibits with a more complex design, such as 'Tension in the Town', required increased visitor effort which only the more prepared or persistent visitors tended to succeed with.

Lesson: Mixing 'easier' and 'harder' exhibits is necessary for preparing visitors for more complex interactive designs.

Visibility of body movement is a key driver for interaction and the choice of augmented-reality and virtual-reality technologies affects this. We see a strong contrast between the virtual reality of 'If these walls could speak' which requires large, visible body movements from visitors, and all the other AR exhibits which involve much smaller movements.

Lesson: Designing interactive exhibits that require visible and obvious body movement can draw more visitors than surrounding exhibits that require smaller, less obvious movements.



Figure 19: Visitor interaction in the museum, 'accumulating' co-visitors

The physical design of the tablets supported visitors handing over the devices to one another, which was a key component of sharing and enabling more visitors to interact. However, this also meant that visitors often missed displays and text contextualising what they were about to interact with.

Lesson: Handovers are a fragile moment during which visitors may miss out on crucial contextual information.

Visitors often repurposed the tablets for humorous or exploratory ends, such as using the camera to appear on-screen for a co-visitor. Visitors also used existing practices, such as pinching gestures to zoom in, to interact with the tablets.

Lesson: Repurposing technology can be leveraged rather than dissuaded.

Eye-tracking study

Eye tracking offers museum staff and researchers a unique view into what a visitor is observing when in front of a museum object. This study focuses on monitoring visitors' attention on the virtual AR and non-virtual museum objects. The six visitor participants who took part in the study wore SMI mobile eye-tracking glass which tracked and recorded their gaze. Each participant spends an average of 20 minutes in the exhibition. For analysis, the researcher looked at three areas of interest (AOI): the physical object, the object viewed through the device, and the AR animation (Figure 20).

The following observations were made:

- Most of the participants focused their attention on the animations and then on the museum object viewed through the tablet. Where part of the museum object was augmented, participants tended to move their eyes between the object on the screen and the animation
- Participants tended to focus on the character's hand or face more than any other digital element in the AR. This leads us to believe that characters bring a more focused attention
- Even with experiences that appear very small on the screen, e.g. 'Trash and Burn', participants tracked the characters' movements through throughout the story
- Visitors rarely moved their gaze between the physical object and screen, with the exception of the 3D-scale model 'Trash and Burn' which seemed to hold the viewer's attention for longer. It could be because the augmentation created an illusion of looking inside the model of the castle, as if the physical wall had disappeared, when intrigued visitors
- Participants sometimes repurposed the tablet, particularly to zoom in on the object. This unintentional use allowed visitors to further investigate the museum object and increase dwell time.

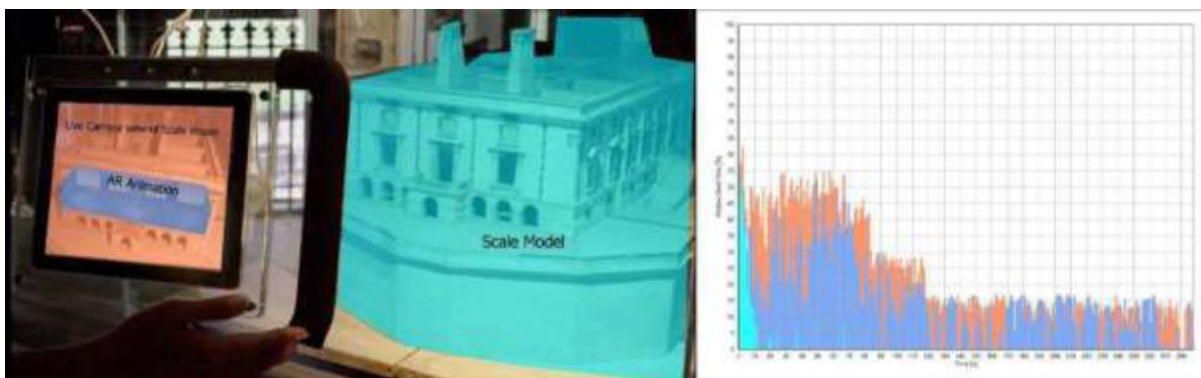


Figure 20: Areas of interest (AOI) and the binning chart for the 'Trash and Burn' exhibit

The AOIs we chose to study were the gaze areas. The different colours in the binning chart in the second image above correlate with the colours of the AOIs in the first image. A binning chart visualises the relative dwell time for the six participants during the period they spent looking at the exhibit. Participants focused the longest on the AR animation area and dwelled on the live camera view of the scale model and actual scale model for a shorter period. They viewed the actual scale model first and then their attention was mostly drawn to the screen.

Visitor survey

A survey of 200 visitors was undertaken between August and October 2016 to measure their attitude to the AR exhibition. Most of the respondents filled in the survey immediately after viewing the exhibition. The majority of respondents came with friends or family; overall, half of them were making their first visit to the museum. The results indicate the AR stories can provide added value to the visitor experience. Satisfaction levels among visitors surveyed were high, with 85% agreeing that the content of the exhibition appealed to them. Many found AR engaging, and the approach to AR storytelling and the exhibition enhanced their knowledge and understanding.

Overall, the experiences seem to have exceeded many visitors' expectations. The survey highlighted some key issues:

- A few visitors indicated that they found the exhibition tablet in the holder too heavy, especially when held up over a period of time. In order to get the right balance between security and flexibility of movement this was a trade-off. There was nothing on the market that could be readily bought. On the plus side, the design entices the user and enables easy handovers
- The sound pollution in the exhibition during a busy period was another issue for some visitors, who said that the various speakers and sounds made it difficult for them to hear the audio coming from the tablet. The sound issue is challenging since the gallery space is relatively small and the tablets are in close proximity. The option of making headphones publically available is not viable in the long term and eliminates the group experience
- One of the unexpected findings of the study was that 'Trash and Burn' was the most popular exhibit among visitors. The team had concerns that the scaled visuals appeared too small. However, over half of all respondents highlighted it and it was the most popular with the 16 24-year-old age group. One possibility of its appeal is its seamless integration with the 3D model or characters and story. Further studies are needed to identify more specifically the role of the individual stories and characters in relation to the visitor experience.

Professional opinion

Interviews with museum staff and an open day with arts professionals with accompanying survey led to the following feedback:

- Most respondents agreed and over half strongly agreed that augmented reality was a viable medium for storytelling
- There is an aspiration to take the technology further to create AR storytelling experiences that are more immersive

'it would be nice to see something that's perhaps even more impressive. I think the augmented reality goes one step towards that kind of immersive experience'

- In a discussion about different types of learner, one interviewee remarked:

'There are a lot of people who don't like to do a lot of reading, so actually having augmented reality means they are gaining some insight into what actually happened back in 1831. In other words, if that hadn't been there they may have just gone in and done a quick tour of the exhibition.'

- One interviewee raised the question of whether the content on the tablets should become part of the archive collection after the exhibition closes.

'How do you archive what you've got [tablets] to ensure that it stays with the object and continues to be accessible?'

It was concluded that this should be discussed with in the collection management group.

- There were concerns about accessibility, in particular the segregation of older generation and/or less experienced visitors. It was suggested that gallery attendants should play a more active role in supporting these visitors
- Concerns were raised about the infrastructure that surrounds the digital exhibition and commitment requirements.

'If you're making that commitment to digital, to move with the times, people expect it to be working. And so you have to make a commitment to making it work. You can't just put it up there and go, it has an ongoing life.'

The project has provoked discussion about whether digital technologies like AR affect the role of the curator. One expert interviewee said,

'I think [it] changes the way write because, it's not linear anymore... It means curators have to be more like storytellers than the traditional curator role.'

Conferences

The researchers and museum staff have spoken at several conferences and published articles and papers on the Museum and Heritage website; at the EVA Conference (Electronic Visualisation for the Arts), London; 'Digital Technology Showcase' at the University Museums Group annual conference; 'Digital Economy All Hands' conference in London; and Museums Association, 'Let's Get Digital: New Strategies for a New Age', Royal College of Surgeons.

Further afield, Ann Priest, pro-vice chancellor and head of college for art and design and built environment at NTU presented a clip of the AR exhibition to the Shanghai Institute of Visual Art (SIVA) for their International Advisory Group meeting. As a result, the SIVA faculty and is keen to contact the researchers to discuss their work and to develop more opportunities for shared student projects.

Insights

The team has drawn up a list of recommendations for arts organisations considering AR as a medium to tell a story or convey a message.

AR as an interpretive medium

The AR interpretation is used to make sense of an historical event through linking several museum objects to site and stories. Because of the interdisciplinary nature of such projects, understanding the interplay between the AR medium and the museum object, between the story and 3D animations, and between physical and virtual space, is essential for communicating the narrative to the audience.

- As a team, allow time to fully explore, discuss openly and understand your medium of choice and its constraints and benefits
- Appreciate that there will be a range of understanding among team members
- Remember you are designing 3D environments rather than 2D animations
- Think through the relationship between the physical and digital environments since these will be simultaneously visible
- Users control the camera angles and duration of the experience. What stories, content and visuals suit this dynamic?
- Audio can play various roles in AR. It can direct users, suggest movement or play a supporting role by creating atmosphere or adding drama. Sound can infer meaning, create the setting and support the text
- Currently, your application will be limited to 50 MB. This will impact your visuals and sound
- Not everything is currently possible in real time, e.g. subtitles, video, and normal tablet functions such as pinch to zoom, are not available when using 3D real-time animations.

Relationship between user interface, sound, visuals and physical interaction



Figure 21: Relationship between UI, sound, visuals and physical interaction

The partners underestimated the cost and importance of the user interface for the interactive design. To engage users in the AR experience, clear visual prompts are required to direct them to the content, which will pay dividends in dwell time. The sound design needs to be valued as it plays a pivotal role in setting the AR scenes and adds value and meaning, as in film or theatre.

- The user interface should be as clear, obvious and instinctive as possible. Where possible, use visual clues and a minimum of supporting words
- Earlier usability testing in the exhibition space would have been significant and saves money in the long run
- A usability consultant would have made a valuable addition to the team
- Emerging technology may not yet have a recognised graphic user interface so may need to be developed
- Sound and visuals need to work together and build in interest the further into the experience they go. If visuals are not interesting, users will walk away halfway through the audio stream
- Physical body movements can hold a user's interest, but users may expect to repeat those body movements throughout an experience
- Generally, users only read instructions if there is a problem or if they can't do what they want or expect to do
- Allocate funds for the various elements of the digital output. Although our project focus was the creation of AR, user interface was still essential.

Physical relationship between user, device and marker



Figure 22: relationship between user, device and marker

The physical relationship between user, device and marker has significant impact on curatorial, content and exhibition design and decision making. Human ergonomics, conservation restraints, health and safety, accessibility, security, and the choice and orientation of the objects in relation to the orientation of the digital environment, all have to be considered.

- Mock-up and test your model with reference to design standards as early as possible into the project, which is more productive than developing a design formula for this relationship
- More space is required around each exhibit to allow for exploration of 3D content
- Think through the physical movements you want your user to make and consider if this informs the design, either physical or digital
- If using museum objects as markers, test them in various lighting conditions to ensure they can function as markers
- Irregular organic shapes and high tonal contrast work best as markers. The display elements or furniture can compensate for any lack of contrast, if required, e.g. a white lace scarf placed on a dark grey fabric
- Exhibition lighting and reflective glass can hinder critical recognition of the marker object by the device camera, so careful positioning is recommended.

Providing devices for public

The permanent AR exhibition was designed as a self-guided experience to allow for discovery and exploration. To enable everybody to access the works, devices are available for public use. These are encased in clear Perspex and tethered to the ceiling to hang down in front of the designated exhibits. Providing tethered devices for public use generates logistical challenges. The design team created a bespoke in-house suspended mount system because there was no available product to suit the need.

The device incorporates the following designs and purposes:

- To limit theft and damage, the tablet is mounted in a secure Perspex and steel enclosure with tamperproof fixings
- Power cable for overnight charging
- To encourage handling, it has padded handles for safety in case a user swings it into the object casing or another visitor!

In the 11 months since installation, two of the five tablets have been completely replaced because of visual pixilation on the screen and damage to the home button. It is likely that repetitive use of particular screen-touch zones may be affecting the responsiveness. More research is being carried out into these 'wear and tear' issues.

One 10mm Perspex holder snapped, while the suspension cable fixing points require frequent attention because children sometimes hang off them. The devices that require 360-degree movement need most attention. The suspension point design is being revisited.

The tablets are programmed to go into sleep mode between 6pm and 9am to charge fully. Therefore, the power in the exhibition space needs to be kept on overnight and fabric covers

are placed over light-sensitive objects every evening. This unfamiliar procedure led to some staff forgetting to leave on the power supply, rendering the devices unusable the next morning.

The public devices are hugely popular, attractive and 'hassle free' for users.

- Ensure appropriate housing products for devices are available that suit your particular needs, or be prepared to compromise
- Be prepared to invest time and resources to create bespoke products if not available
- Be aware of the practicalities and financial commitments to deal with maintenance issues on a sustainable basis
- Staff awareness and training needs to be delivered as part of your project and be ongoing
- Be prepared for users to abuse or find alternative uses for anything in a public exhibition
- Health and safety issues apply to technology!
- The powering and re-charging of devices is a critical issue that needs careful thought from the outset.

Technology team insights

Based on their experience of designing and building the AR app in collaboration with the arts organisation and research partner, the technology team reflected on the impact that this experience had on them.

Contrast between R&D and commercial work

Corporate and commercial companies will select a technology company based on what they know they can achieve within a given budget and timeframe. An R&D grant gives you a fluid outcome and the creative freedom to take risks or fail.

Collaborative working

There was an interesting shift and fluidity in the relationship model throughout the project. Operating as an equal partner in a collaborative process was new to us, but after a period of development the relationship became more like that of client and provider, with us as provider.

UX design challenges in AR

Designing interactive elements for AR brings its own set of challenges. People are now familiar and fluent in the graphic interface and visual language that has grown up around the web, but AR is still emergent and has specific limitations. For example, there isn't cursor and buttons can exist in 2D or 3D space, which means they change size and position.

Future

RIOT 1831 and the partners

The project achieved its purpose and contributed to museum staff being more engaged in the complexity of integrating digital technology for future exhibitions, but there is still more work to be done. As visitor expectation and technological capability increase, the museum will need to think about how to establish a greater digital relationship to its collections. The real challenge is in adapting emergent technologies like AR into an interpretive medium that is relevant and meaningful for the 'active' visitor.

Preliminary discussions are in place between the partners to apply the technology and learning to another NCMG site, and to investigate how to utilise the digital assets for future AR applications at Nottingham Castle, such as using the animated James Marriott character in the front of the real castle lodge.

The RIOT 1831 exhibition remains on display for a few years, which will allow the researchers to undertake further studies for improving app usability and to assess the impact of AR technologies on storytelling and the learning environment for both on-site and off-site applications, and the value of eye-tracking visitors for interactive museum exhibitions. The history input from Dr Richard Gaunt, University of Nottingham, during this project has led to a part-time academic residency for three years at NCMG.

Working in an R&D context, museum staff appreciated the merits of collaborating with art and design researchers and more participative audience research, which has informed future practice.

The project involved a cultural shift for Hot Knife Digital Media, from thinking of themselves as a service provider to a production company, and has taken them into new territory regarding technical production and output. The team has learned new processes akin to gaming production, and new skills and ways of working; by creating real-time 3D content for mobile apps they have started producing outputs in a different medium. The project has also opened up new market opportunities and income-revenue streams that have led the company to start selling the skills they've attained to new clients. Hot Knife have subsequently taken on more freelancers to cope with the demand. They are researching how the AR technology can be further developed for the public and commercial sectors, particularly in the entertainment industry.

AR interpretative exhibitions

AR is challenging and can be expensive and disruptive to exhibition development but offers unique opportunities as an interpretive medium. It can add meaning, create interactive dialogue between sound, visuals and the physical object in real time, and is particularly suitable for museums and organisations with people-centred stories linked to their sites.

AR is commonly added to existing exhibitions, which lowers the cost, but this could limit its use as an interpretative medium. In the context of a new exhibition and bearing in mind the in-kind support from partners, the bespoke technology and in-house exhibition design and build, it is difficult to make cost comparisons with previous work. Exhibition design and build, including tech, generally costs £2,500 per square meter; RIOT1831 exhibition area is 168

square meters, which comes to £420K. Our total estimated costs were £262K, making our approach more cost effective.

Using a theatrical storytelling approach means AR can facilitate the moving body and create alternative viewpoints and dramatic illusions, caused by the live camera incorporated with characters and short animated stories. The viewer/participant 'does more' by putting the story together and is visually and physically engaged. Dwell time is increased as the content goes beyond the novelty and offers meaning and value to the visitor experience.

Resources

Project information

Project website: <http://www.riot1831.org/>

Behind-the-scenes videos on YouTube: Riot1831@Nottingham Castle

Insights on Native website: www.artsdigitalrnd.org.uk

To download the app and visit the exhibition: www.nottinghamcity.gov.uk

To contact partners:

NCMG: adrian.davies@nottinghamcity.gov.uk

Hot Knife Digital Media Ltd: andrew.whitney@hotknife.co.uk

Roma Patel: roma.patel@nottingham.ac.uk

Tools and guidance

<http://www.hotknife.co.uk>

<http://unity.com>

Further reading

Lecture series on storytelling in media: <http://prezi.com/user/brackin/> Spatial Narratives in Art:
<http://lilyhonglei.com/invisible-pavillion.pdf>

Julius Panero and Martin Zelnick, Human Dimension and Interior Space. A Source book of Design Reference Standards

AR examples

The Fantastic Flying Books of Mr. Morris Lessmore

<https://moonbotstudios.com/work/the-fantastic-flying-books-of-mr-morris-lessmore/>

Peter Weibel, Life in the 20th Century | 225 Million Murders. An Augmented Reality Installation (2011)

AR at the British Museum: <http://www.britishmuseum.org/learn>

AR@ Museum and the Web

https://www.museumsandtheweb.com/paper_keywords/augmented_reality_0.html

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Glossary & Abbreviations

AOI area of interest

AR augmented reality

BSL British sign language

NCMG Nottingham City Museums & Galleries

QR quick response

SIVA Shanghai Institute of Visual Art

UI user interface

UE user experience

Acknowledgements

NCMG staff, particularly Ron Inglis (service manager, chair of quarterly meetings), the curatorial team, volunteer co-ordinators, and Stephen Chartres (critical friend)

Focus group members

NTU marketing staff and research office, particularly Julian Clarke (bid application)

Sally Bowden, Centre for Advanced Studies, University of Nottingham

Appendices

Appendix A: 3D animations

Five separate AR experiences were created for the exhibition and one for use at home. The 3D animations for the exhibition are captured in the section below.

Tension in the Town

The first animation in the sequence was designed to augment a lace scarf in the museum's collection. It introduces the story of the riots from the point of view of a young boy as he helps his mother unpick her misplaced stitches as she makes a lace scarf. The animation focuses on the boy's hand as he unpicks the stitches. The challenge was to prevent the arm from looking disembodied. A rough-looking fade was applied to the arm to make it appear less abrupt and a false shadow created to make the hand look like it was part of the scene. The main digital asset is a candle, so a false overlay of a semi-transparent flickering light was added to give the impression of candlelight affecting the whole environment.

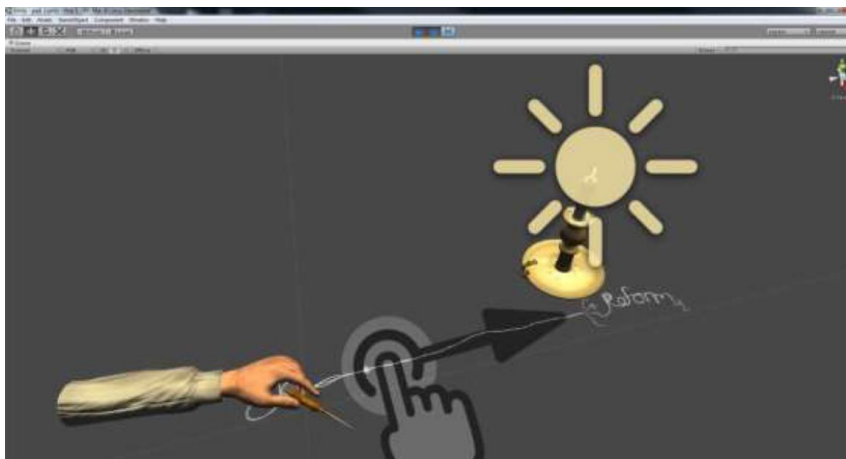


Figure 23: Boy's hand unpicking the stitches

The Marriotts Versus the Mob

Designed to augment a painting of the castle lodge, the animation tells the story of James Marriott, the castle's lodge keeper and his wife, as they react to the mob's attack on the castle. The narrative is taken from James Marriott's testimony in court and the animation starts with the courtroom fading out to reveal James Marriott and his wife in the lodge as the mob attack.

There were two main challenges: firstly, the animation had to represent a mob; secondly, it had to give the impression of night time when the painting depicted the lodge in daylight. The solution devised by the creative team was a highly theatrical and non-realistic interpretation using the conceit of a stage curtain rolling down over the painting to reveal a night-time scene, supported by the image of a picture frame flying in to visually frame the image and the presentation of the mob as silhouettes.

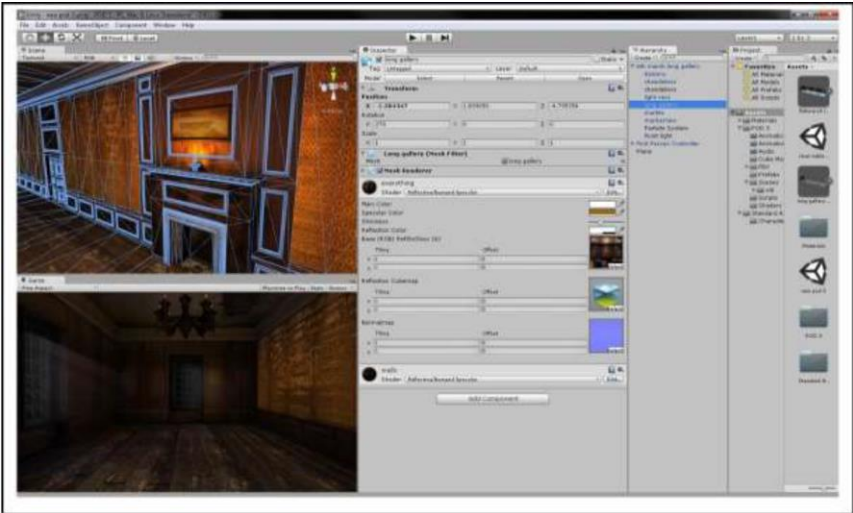


Figure 24: Long Gallery work in progress

Trash and Burn

A 3D model of Nottingham Castle was augmented with an animation showing the inside of the Long Gallery. The narrative reveals the lead rioter’s antipathy to the aristocracy and the user is invited to collude with him by helping to burn down the gallery by stacking furniture. The theatrical conceit continues with the Long Gallery represented as a stage. The lead rioter crashes through the window, walks to a door and opens it, inviting the user to interact by moving chairs onto the fire at centre stage. The experience posed a number of challenges: time and budget limited the number of rioters and the lighting effects; the user interaction appeared very small on a mobile phone; and there was a technical challenge in aligning the animation to the museum object so that the room looked like it was inside the castle.

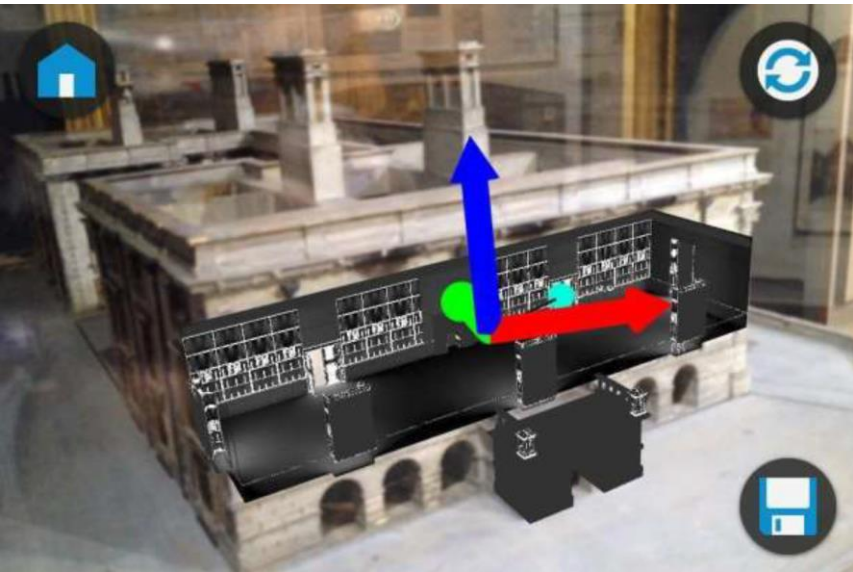


Figure 25: Trash and Burn aligning models

Watching from Windows

A dramatic oil painting showing the castle in flames was augmented with fire and smoke effects. The oil painting didn't have enough contrast to be tracked accurately so the detail on the graphic panel surrounding the painting was increased to enable tracking of the panel instead of the painting. To create a night-time environment in a museum gallery in daylight the user's view of the painting through the device was artificially darkened with dark clouds to create a vignette effect.

Theatrical techniques were again employed to counteract some of the representational challenges. The narrative is based on the account of a young girl who watched a crowd gather below her window to sell fragments of tapestry from the castle at three shillings a yard. The crowd is represented using an animation of jostling umbrellas viewed from above, with the financial transaction depicted through an exchange between two built characters.

Appendix B: Learning box

Early on in the process the team decided to create a learning box as a project output. This was to provide wide access, to embed the project in the museum service offer and to encourage the team to think about how the digital assets could function away from site. NCMG has an 'Access Artefacts' handling collection for school and community groups, with 75 resource boxes available for loan. For the first time, technology is being offered as part of the handling collection service: users will be able to handle historical objects linked to the project's thematic content and use a tablet with the RIOT 1831 application installed to interact with graphic copies of the AR markers. The resource is a portable AR exhibition linked to the National Curriculum for all key stages or community groups (see Figure 26). This is being evaluated beyond the lifespan of the project.



Figure 26: Learning box contents



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