CAN AUGMENTED REALITY ‘CROSS THE CHASM’ FOR USE IN MUSEUMS AND GALLERIES?

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SYNOPSIS

Innovations in digital infrastructure and systems can influence the economic, political, social and leisure landscapes, enabling opportunities to implement new business models, forms of social interaction and ways of consuming media and entertainment.

Digital technologies can be used by organisations to create new customer value propositions. For museums and galleries, digital innovations can enable new exhibitions and visitor engagement programmes.

Augmented Reality (AR) is an emerging digital innovation predicted to grow significantly. AR systems overlay digital information on a real-world view - often using a webcam or mobile device - allowing users to see digital information and the real-world at the same time.

This study asks whether AR has or will ‘Cross the Chasm’ (Moore, 2006), to become a mainstream digital innovation for use on-site in museums and galleries. ‘Crossing the Chasm’ requires an innovation to be sufficiently developed to be adopted by pragmatic ‘early majority’ consumers.

This study concludes that AR will ‘Cross the Chasm’ for use on-site at museums and galleries, lagging the commercial-sector by 1 – 2 years, due to specific technical issues and perceptions of high cost.

Development of AR systems and infrastructure is likely to encourage mainstream adoption of AR in commercial sectors during 2011 – 2012, driven by significant investment and hardware development.

Museums and gallery organisations are currently the unit of innovation-adoption for AR. Organisations should consider development of innovation strategies, which include use of structured design processes, to differentiate their visitor offer and generate competitive advantage.
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1. INTRODUCTION: DIGITAL INNOVATION

Digital systems and infrastructure are increasingly influencing society and the economy. Digital tools can enable businesses, organisations, governments and individuals to develop new models and systems for economic and social interaction.

In developed countries the use of digital technologies has become a part of most people’s daily lives. Almost 2 billion people have access to a device that connects with the internet and over 5 billion people use mobile telephones (Internet World Stats, 2010). In many areas digital infrastructure provides the enabling foundation for a range of regular social and economic activities.

Over recent decades, the growth of the internet and digital communications has opened a range of new opportunities for people to interact and share information. Digital infrastructure can support and enable organisations in the media, entertainment and leisure industries to develop and deliver new experiences and value propositions to their consumers (Jenkins, 2008).

The rate of technological change is high, and it is unclear which new digital innovations will become mainstream, and which will be surpassed.

This study considers the use of one relatively emerging innovation in digital technology – Augmented Reality (AR). Against the backdrop of a digitally enabled economy and society, this study asks whether AR will be become a mainstream technology and tool for use on-site at museums and galleries.

Implementation of innovative digital technologies has been shown to help museums and galleries differentiate their offer and provide visitors with enriched experiences to enhance their visits. However, digital tools can also be costly failures if they fail to deliver benefits to the visitor or organisation.

With a growing awareness of AR, this study’s research questions aim to assist organisations in understanding the potential benefits of AR, and how they might be captured; while identifying and avoiding the dis-benefits.
1.1. Digital technologies in the cultural sector

Digital technologies and systems can open opportunities for new ways of delivering value to consumers in a variety of sectors and industries. Digital tools support organisations and individuals in developing and delivering alternative value propositions.

The increasing range of digital systems implemented across sectors raises the public's expectations of what organisations can and should deliver using innovative new technologies. As the expectations of an increasingly connected society change, so too are the expectations of visitors to museums and galleries likely to change.

The museums and galleries sector has experience in using digital technologies and systems to support delivery of organisational aims and objectives. Despite sometimes being viewed as relatively slow to embrace innovation, the museums and galleries sector has long used the internet to communicate with visitors:

‘by 2002 more people were visiting museums’ websites than were visiting the museum in person’.

(Hawkey, 2004)

In addition to the internet, museums and galleries have a range of tools available to enhance visitor engagement, using digital technologies to create new ways of interpreting and presenting exhibitions and artefacts.

As new digital innovations enter the market on a regular basis, this study considers the potential impact that one emerging technology - Augmented Reality (AR) – could have on the museums and galleries sector.

AR overlays digital information on a real-world view - often viewed through a webcam or mobile device - allowing users to view digital information and the real-world at the same time.

AR encompasses a range of digital systems, tools and technologies and has been used in the commercial and cultural sectors in areas from product advertising to
delivery of services; and from information delivery at exhibitions to the creation of art works.

ABI Research (2009) predicts that the AR market will increase from $6 million in 2008 to $350 million in 2014. Even larger increases are predicted from Juniper Research (2009), estimating 2010 revenues at $2m, before rising to $732 million in 2014.

AR has been used by organisations in the cultural sector since the late 1990s for presentation and interpretation of exhibitions and experiences. Over recent years, the museums and galleries sector has used AR in a number of applications; a notable example during this study was the launch of the Museum of London’s Streetmuseum iPhone application (Museum of London, 2010).

Given the experience some museums and galleries have with the use of digital systems and infrastructure, this study considers whether museums and galleries have the right core capabilities to adopt an emerging digital innovation such as AR.

**1.2. Innovation research on development and spread of new technologies**

The potential for innovations, including digital technologies, to become mainstream depends on a range of factors and is an area of extensive academic research.

The academic literature on innovation guides the collection and analysis of evidence for this study, and is used to draw conclusions on the potential for AR to become mainstream in museums and galleries.

For innovations to become mainstream, they must be taken-up by ‘early adopter’ consumers; before moving to the larger group of mainstream consumers in the ‘early majority’ (Rogers, 2009).

There is some debate over whether the move from one group to the next is continuous – the view of Rogers (2009); or whether a ‘Chasm’ exists between the two groups – the view of Moore (2006).
Moore believes that there is a ‘Chasm’ between the risk-taking ‘early adopters’ and the pragmatic consumers who form the ‘early majority’ mainstream. The difference, according to Moore, in the buying behaviours of the two consumer groups makes it difficult for innovations to move smoothly from the ‘early adopters’ to the mainstream ‘early majority’, causing many innovations to stall and fail.

This study considers whether there is a ‘Chasm’ between the consumer groups relevant to use of AR in museums and galleries, and asks whether AR has the right innovation characteristics to enable adoption by mainstream ‘early majority’ consumers.

1.3. A mixed methods study to answer the key research questions

This report is structured around the mixed methods design, and attempts to answer the research questions set out in section 2.1.

The report begins by setting out the research questions and objectives, before describing AR and presenting a range of examples. The literature covering the uses of AR in the cultural sector; and the adoption of innovations is reviewed in section 3.

The review’s mixed methods methodology is described in section 4, along with detail on the structure of primary data collection.

Section 5 presents and discusses data collected during the study. Primary data from interviews, questionnaires and observational studies is presented, supplemented by secondary data sources. Evidence and discussion is set out under three headings, which were drawn from qualitative interview evidence and which follow Moore’s ‘Competitive-Positioning Compass’ (2006).

The headings are phrased to follow Moore’s model, and to provide a high-level summary of the findings in each area.

- TECHNOLOGY: Despite technological advancements in AR some issues persist; but costs are falling;
- PRODUCT: a structured design process should be considered; AR can add value to a visit; and
• **MARKET:** *Innovation can help build competitive advantage; organisations are not set up for innovation.*

Finally, section 6 draws on the data and analysis to derive a series of conclusions and recommendations, designed to support and guide museums and galleries in the use of AR. Areas of potential further work are highlighted.

A list of references is provided in section 7. A number of appendices are attached in section 8, comprising relevant background information, tables and resources used during this study.

A shorter version of this report will be produced, to provide organisations with a high-level summary of the key findings and recommendations.
2. RESEARCH QUESTIONS AND BACKGROUND TO RESEARCH

2.1. Aims and objectives of study

Key research questions

- Does Augmented Reality add value to a visitor’s experience?
- Does Augmented Reality offer advantages over other digital tools used by museums and galleries?
- What is the role of the museum or gallery in adoption of Augmented Reality?
- What are the current and future expectations around cost and usability of Augmented Reality?

Leading to the key question:

- Will the use of Augmented Reality on-site at museums and galleries become mainstream?

As an emerging and developing technology, relatively little research is available to help guide organisations considering the use of AR. The research questions were chosen to guide a study that would be of use to the sector; particularly through using academic business and innovation models to inform and guide decision making.

Objective of study

The key objective was to undertake an independent and timely review of an increasingly popular, innovative new digital technology, and consider whether its use can deliver sufficient value to buyers and end-users to make its use mainstream.
2.2. What is Augmented Reality?

Augmented Reality (AR) can be defined as a technology that:

- Combines real and virtual objects in a real space
- Is interactive in real time
- Registers objects in 3-D

(Azuma, 1997)

Or as Foni et al (2010) defines it ‘AR systems enhance the real world with computer-generated virtual objects that appear to seamlessly coexist in the same space as the real ones’.

AR is part of Milgram’s Reality-Virtuality Continuum (Milgram et al, 1994), where a real-world environment is added to, by overlaying virtual computer-generated images, text or other information, as shown in figure 1. AR is part of the wider range of mixed-reality (MR) systems and technologies.

![Milgram's Reality-Virtuality Continuum](image)

*Figure 1 - Milgram’s Reality-Virtuality Continuum. Source: Milgram et al, 1994.*

AR is not a new concept. The concept of augmenting reality can be traced back to the ‘Peppers Ghost’ theatrical effect of the 1860s, where mirrors are used to augment stage shows with ghostly figures (Wikipedia, a).

![Pepper's Ghost](image)

*Figure 2 – Pepper's Ghost: augmented theatrical effect. Source: Ghost Theory.*
Figure 1 shows how the use of mirrors and lights can project an image of a ghost onto the stage, while the actor is hidden from the audience’s view on the bottom left.

With the development of computer technology, the potential for virtual augmentation of physical space became possible. Since the late 1990s, the field of AR has become increasingly popular, both for academic and commercial use. High powered computing devices now make possible what was once only achievable in controlled research settings.

AR comprises a range of applications and technologies. AR is already used in a number of settings, the most widely known being ‘heads-up displays’ used by pilots and increasing numbers of car drivers, as shown in figures 3 and 4.

![Figure 3 – Pilots ‘heads up display’. Source: Wikipedia, b.](image)

![Figure 4 – Car ‘heads up display’. Source: Gadget Venue.](image)

The boundaries around what is and what is not considered to be AR are blurred.

**Types of AR**

Given that there are a wide range of uses of AR, there have been efforts to identify, define and standardise the technology and systems. The lack of standards and fast pace of change means that the examples and definitions given in this study are likely to be quickly out of date.

To assist with standardisation of AR and to encourage increased public awareness, industry-leading company Total Immersion has suggested an AR logo should be used wherever AR technology or tools are used, figure 5. This follows earlier similar efforts by Augmented Reality Logo in 2009.
The current range of AR applications has been succinctly mapped by research consultancy First Partner (2010), and broadly falls into three categories:

- **Marker-based** – uses marker tags recognised by a computer or mobile device to launch content that is overlaid on real-world image seen on screen. Markers can be specific patterns or recognition of known images from a database;

- **Marker-less** – mainly for mobile devices equipped with GPS location awareness and compasses. AR overlays digital content on the camera screen, relevant to the location; and

- **Augmented vision** – highly developed form of AR where images are presented either on or in front of user’s eyes, which requires advanced technology not generally available at present.

For this study, a further level of definition is required. Within the three categories – particularly marker-based, there are AR uses that require complex technology; and those based on relatively simpler technology:

- **Complex technology** (termed ‘professional technology’ in this study) – includes static AR experiences utilising large display screens and glasses for the user. Such examples often use markers to create 3D images that users can interact with in real space. Examples include the Interactive Virtual Showcase or Spinnstube as shown in figures 11 and 12.
• Simper technology (termed ‘consumer technology’ in this study) – involves the use of widely available computers, laptops, webcams and mobile devices. Today’s powerful consumer electronic devices make a range of AR uses possible. The term ‘consumer technology’ is used in this study to signify the difference to ‘professional technology’ implementations.

Examples of AR - marker-based

Consumer technology

At present, AR is most commonly used in advertising and marketing using consumer technology to enhance engagement with customers. Examples in figure 6 make use of computers equipped with webcams. Certain markers (special clothing; a persons’ head; or a printed tag) are recognised through the webcam, and are used to launch content that is overlaid on the computer screen. The aim is to provide the user with a more immersive and interactive experience of a product or service.

Figure 6 – Use of various markers to launch content via computer webcam.
Sources: Daddy Types, 2010; Online and Mobile, 2010; Technomarketer, 2009.

Other deployments of marker-based AR use mobile devices and markers to launch content. Figure 7 shows the Viz*it AR experience at Andover’s Museum of the Iron Age, which was a subject of primary research for this study. Figure 8 is an AR business card, where a marker on the business card launches a picture of the card owner’s face. Figure 9 uses visual search rather than a printed marker and figure 10 is an example of in-store advertising using markers on product packaging to launch AR content.
For use with a mobile device, a marker launches a 3D model of an Iron Age soldier, who talks for around 30 seconds about what it was like to live and fight in the Iron Age.

Figure 7 – Museum of the Iron Age. Source: Ambient Performance, 2010.

Used with a mobile device or a computer and webcam. A business card has a marker on the back that launches a video of the person talking. Artistic effects are used to render the video in 3D depending on angle of the card.

Figure 8 – AR business card. Source: Alliban, 2010.

For use with mobile devices. The image viewed through the device’s camera is used to run a web-based search to identify the subject. Information about the subject is then presented, sourced from the web.

Figure 9 – Google Goggles visual search. Source: App Advice.

Use of AR with a static in-store kiosk based on a computer and webcam. Shoppers hold a Lego box up to a webcam, which recognises the box and overlays a digital image of the fully built toy on the screen.

Figure 10 – Lego in-store AR. Source: I Love New Work, 2009.
Professional technology

Professional technology can be used to create AR marker-based experiences where users can view and interact with virtual objects in real space. Such marker-based AR has been used in museums and learning environments to give users a more immersive experience. Examples below include AR to view museum objects; and AR that helps learning through visualisation of a virtual 3D cube in real space.

Users wear glasses to view 3D objects based on the museum’s collections. Visitors are able to view and interact with objects either alone or as a group.

Figure 11 – AR experience at the Deutsches Museum Bonn. Source: Wendler and Fröhlich, 2005.

Spinnstube table-top AR. Table-top AR uses markers, cameras and a projector to create a digital 3D model in physical space. The user wears glasses to visualise a cube in 3D space, and interacts with the cube using a light pen. Allows for immersive interaction by one or more users in real-time.

Figure 12 – Spinnstube AR experience, 3D cube. Source: Author’s photos.
While marker-based AR is currently the most popular form, some believe that it may not be the future of AR. For example, at a 2010 AR conference, renowned AR blogger Bruce Sterling commented that ‘markers are endearing toys and gimmicks’ (Sterling, 2010), possibly indicating that marker-based AR may be limited.

Examples of AR - Marker-less

While marker-based AR is sometimes seen as limiting in use and value, marker-less AR is viewed by some as offering greater potential. Marker-less applications have a wider range of uses, as they do not rely on a printed tags or image recognition (Johnson, 2010a). Marker-less AR applications can be used to assist navigation and to provide context, as shown by the examples below.

Location aware AR tour guide, overlays information relevant to the location and direction in which the device is pointing. Uses GPS and compass to call information from a database.

*Figure 13 – AR used as a tourist navigation tool.*

AR car satellite navigation. Uses GPS and compass for location awareness. Camera used to show road ahead and overlays route information and directions onto real-world view.

*Figure 14 – AR used in car sat-navs. Source: Slash Gear.*
Marker-less AR has been used in the cultural sector where mobile devices with location awareness (via GPS and inbuilt compass) are used for navigation and contextualisation of the visit.

The Louvre provides a mobile location-aware device to visitors. A character appears on the screen to give visitors information on the gallery and exhibits, as well as navigation around the gallery. A balloon is used to help visitors navigate, showing which direction they should walk.

![Figure 15 – AR at the Louvre, used for navigation and information. Source: Valeotini, 2010.](image)

The character appears on screen and narration can be heard through headphones provided.

![Figure 16 – AR at the Louvre, used for navigation and information. Source: Valeotini, 2010.](image)

A highly popular AR application for mobile devices. Photographs from the Museum of London archive are annotated with precise location information which allows a mobile device to overlay the image on top of the real-world street seen through the device’s camera.

![Figure 17 – Streetmuseum, overlays historic photos on top of the present-day view seen through the device’s camera. Source: Museum of London, 2010.](image)
Head-mounted devices have been used to view historic reconstructions of archaeological sites in real-time. Used at a number of European sites.

*Figure 18 – ARCHEOGUIDE AR, overlays an historical reconstruction on top of present-day view. Source: ARCHEOGUIDE.*

**Examples of AR – Augmented Vision**

Augmented vision is rapidly developing, but is still in a relatively early stage of development, and not yet in general public use.

Digital information is presented on glasses worn by the user, specific to the location and chosen context.

*Figure 19 – Augmented vision glasses. Source: Me The Media.*

Use of augmented vision glasses to show genealogical information on the deceased, overlaid above their graves.

*Figure 20 – Augmented vision used to show context-relevant information without a screen. Source: Portal To Your Dreams, 2009.*
The future of augmented vision is predicted to be contact lenses worn by the user, overlaying information directly into the user’s field of vision, with no need for a screen or glasses. 

*Figure 21 – Augmented vision contact lenses.*

**AR – a hot technology**

‘AR’ has been identified by various commentators as being an upcoming technology. In 2008, the market research firm Gartner tipped AR to be a disruptive technology (Gartner, 2008); and numerous news reports, including the BBC (Wakefield, 2009), identified 2010 as the year of AR.

Analysis using the Google trends tool highlights the increased public interest in AR. Figure 22 shows the number of Google searchers for ‘augmented reality’ has increased significantly over 2009 – 2010.

*Figure 22 – Google searches for ‘augmented reality’. Source: Google, 2010.*

It should be noted that figure 22 includes data on all forms of AR, from marker-based through to augmented vision.
As with many innovations, some believe that expectations are over-inflated for what AR can and will deliver. Gartner’s latest update of their technology hype cycle – figure 23 – plots the expectations of various innovative technologies. Gartner (2010a) places AR towards the peak of ‘overinflated expectations’, which could mean a bubble is about to burst for AR.

This report considers some of the factors museums and galleries should consider if or when implementing AR, to help avoid the ‘trough of disillusionment’.

**When and where is AR used in the cultural sector?**

AR has been used in the cultural sector, along with other mixed and virtual-reality tools. A number of EU funded cultural projects using AR have been delivered including ARCHEOGUIDE, ARICH (Augmented Reality in Cultural Heritage) and ARCO (Augmented Representation of Cultural Objects), as discussed in the Literature Review.

AR can be used off-site to enhance visitors’ engagement pre and post-visit, for example by using AR markers to access certain digital content via computers or
mobile devices. These applications could be used to give visitors greater depths of information; to extend engagement in the visit; or to entice people to revisit. Printed material including tickets or exhibition brochures can include markers that are used to launch AR content.

On-site, cultural institutions use a range of marker and marker-less AR applications. On-site AR experiences are often delivered via mobile consumer technology devices, but can also be tethered professional technology screens – for example an AR experience at At-Bristol science centre, reviewed as part of this study. AR can be used on visitors own devices; or using devices provided by the organisation.

The Literature Review section of this study identifies whether AR adds value to a visitor’s experience.
2.3. Background on innovation in museums and galleries

The Literature Review in section 3 defines and discusses innovation, and sets out the models which guide this study.

In the context of this study, important background is the technology lifecycle as applied to museums and galleries. Figure 24 sets out the technology adoption life cycle as perceived by Rob Stein of the Indianapolis Museum of Modern Art (Stein, 2010).

Figure 24 shows that AR is a relatively new technology for museums and galleries, yet to have widespread use in the sector. This model is presented in this background section, as AR’s perceived stage within the lifecycle determines much of this study’s findings from the literature review and data collection.

![Museum and Gallery Technology Adoption Life Cycle](image)

Source: R Stein, Tate ‘Museums and Mobiles’ symposium, 2010

*Figure 24: Museum and Gallery Technology Lifecycle. Source: Stein, 2010.*
3. LITERATURE REVIEW

The Literature Review is divided into two sections. The first considers the range of academic literature on uses of AR and digital technologies in the cultural sector, highlighting key findings. The second focuses on the literature around the adoption of innovation. Both sections provide the academic foundations for this study.

3.1. Literature on the use of AR and digital technologies in the cultural sector

Since the late 1990s there have been numerous academic studies into the use of new digital technologies to assist the delivery of visitor experiences in the cultural sector.

The literature covers a range of uses across museums, galleries, archaeological sites and other cultural attractions. Given that AR is part of mixed-reality (MR) (Milgram et al, 1994) the literature covering a AR and MR was reviewed.

There have been some attempts to categorise the types of AR and MR (First Partner, 2010), and to set these tools within a wider taxonomy of tools that can be used by the cultural sector (Foni et al, 2010). It should be noted that ‘reflecting the early stage of the technology, much of the research into AR focuses on technical issues’ (Pemberton and Winter, 2009). The relatively early developmental stage of AR means there is limited reference in the literature to the uptake of AR as an innovation, or the value it creates for visitors/users. This is a limitation of the literature in relation to the focus of this study.

Uses of AR in the cultural sector

A wide number of papers cite implementations of AR at cultural heritage sites. These include a Pompeian Tehermopolium, part of an UE funded LIFPLUS programme (Papagiannakis et al, 2005; and Vlahakis and Ioannidis, 2005); the ARCHEOGUIDE EU funded project at Olympia, Greece (Striker et al, 2001); and the ARCO European Union funded project (Mourkoussis et al, 2002 and Sylaiou et al, 2010). A recent review of uses in the museums sector is provided by Jonson et al (2010b). Although overtaken by technological developments, the earlier AR
implementations provide foundation learning used by many later studies, and were a source of core understanding for this study on how AR delivers visitor value.

The literature shows that use of MR by the cultural sector always generates positive feedback from visitors (Grasset et al, 2007). However Grasset et al (2007) and Woods (2004) note that the ‘fun effect’ of the technology can become the focus of the exhibit, rather than on the underlying exhibit itself. These findings are of relevance to this study, as the provision of an enjoyable experience is shown to create value for visitors, which can help an innovation become more widely used.

AR and MR have also been widely used for educational purposes, as reviewed by Winter and Pemberton (2008). Winter and Pemberton define learning as the ‘encouragement of a wide range of experiences, skills, dispositions and behaviours.’ AR is identified as being able to increase visitors’ motivation for learning. As learning is often a key outcome and area of value for museum and gallery visitors, Winter and Pemberton’s review findings are considered important for this study.

**Digital technology user groups**

A common perception of digital technologies is that they only engage younger generations and are a turn-off for older visitors, particularly those aged 50 and over. Hornecker and Stifter (2006) highlight that well designed interactive exhibitions (which could include AR) can engage ‘visitors across age and interest groups’. This work is referenced in numerous other papers and shows that well-designed digital experiences do not necessarily discriminate against older visitors.

**Areas where AR may add value to cultural institutions**

In a number of studies of AR and MR, authors highlighted areas where the technology can be of particular use in creating visitor value. The literature appears to lack a clear grouping or overview of these value areas. While the literature lacked a single overview, each author’s identification of value areas is considered instructive in helping guide organisations on future implementations.
As part of this study, the value areas of AR have been noted, and grouped into the following seven value areas:

1. Personalisation: the potential to offer different visitors different levels of augmentation or information for the same object or exhibit (Liarokapis et al, 2008; Pemberton and Winter, 2009; Winter and Pemberton, 2008; Woods, 2004);

2. Enhancement of physical objects or spaces in ways that are otherwise not possible (Billinghurst, 2002; Damala et al, 2007; Foni et al, 2010; Johnson et al, 2010b; Styliani et al, 2009; Tallon, 2010b; Winter and Pemberton, 2008; Wojciechowski et al, 2004);

3. Enhancing understanding of the context of objects or spaces (Billinghurst, 2002; Grasset et al, 2007; Liarokapis et al, 2008; Styliani et al, 2009; Winter and Pemberton, 2008; Wojciechowski et al, 2004);

4. Providing an interactive, hands-on experience (Foni et al, 2010; Hornecker and Stifter, 2006; Styliani et al, 2009);

5. Engaging group interaction during visits (Hornecker and Stifter, 2006); a key consideration for most museums and galleries where most visitors come in groups;

6. An enjoyable, entertaining and new experience (Grasset et al, 2007; Liarokapis et al, 2008; Sylaiou et al, 2010, Winter and Pemberton, 2008); and


The seven value areas drawn from the literature could be a useful guide for organisations considering the implementation of new AR tools.

For most of the value areas, the ease of use of AR is paramount. The importance of AR applications being easy and intuitive to use is identified by a number of authors, including Hornecker and Stifter (2006), Liarokapis et al (2008) and Wojciechowski et al (2004). While well designed applications can be successful, it is interesting to
note that some authors caution that AR can be a solitary and dividing experience if solely delivered over smartphones (Museum of the Future, 2010).

Also identified as highly important is the necessity for high quality content, whether for an AR application or for any new exhibit (Hornecker and Stifter, 2006).

A majority of the literature highlights the significant potential of AR to be used increasingly in museums and galleries. However, Winter and Pemberton (2008), among others, sound some caution by identifying the key issues that hold back AR:

• Technological shortcomings;
• Usability issues; and
• Lack of authoring tools and standards for content creation.

Further work is required to develop AR in the cultural sector

As AR is a relatively new technology and study area, a number of researchers have highlighted the need for more work, as summarised by Winter and Pemberton (2008):

‘AR is a young technology that still needs substantial development in order to produce robust, reliable and affordable applications.’

Reviewing the literature on the use of AR in the cultural sector highlighted that studies are mostly based on qualitative and observational data, with a lesser reliance on quantitative data sets. While this aids the potential to draw out lists of areas where AR adds value, it makes robustly proving those value areas more difficult.

The literature does not consider the role of the cultural sector organisation in the adoption of AR. In some cases mention is made of the need for strong leadership, but in general the focus is on the technology and, to a lesser extent, the user/visitor. The lack of literature on the organisation is a limitation for this study and is an area of possible future work.
3.2. Literature on the adoption of innovation

There is a wide body of literature defining innovation and how innovations are adopted or diffused. For this study innovation is defined as:

‘an idea, practice or object that is perceived as new by an individual or other unit of adoption’

(Rogers, 2009)

Others define innovation as:

‘the successful exploitation of new ideas. It is the process that carries them through to new products, new services, new ways of running the business or even new ways of doing business.’

(Cox, 2005)

AR fits within these definitions, as AR is seen by most authors as a new technology supporting new products, services and experiences.

Types of innovation

The literature identifies a number of types of innovation, which are well summarised by Dodgson et al (2008). Innovation can be an outcome – for example a new digital user experience. It can also be a process that organisations follow to make managerial and organisational decisions (Dodgson et al, 2008).

For this study, an area of focus are those innovations identified as being either ‘continuous’ or ‘discontinuous’ in how the innovation affects current ways of doing things (Tushman and Anderson, 1986). Christensen (1997) uses the terms ‘sustaining’ and ‘disruptive’ for such innovations.

‘Disruptive innovations’ are those that undermine existing products or services and can often make significant impacts in creating new markets. Christensen’s ‘disruptive innovations’ models are often used to describe innovations, including AR, that change the status quo and offer users an enhanced value proposition. Gartner (2008) identified AR as a disruptive innovation likely to change the business landscape.
In figure 25 Christensen’s theories on disruptive innovations are put into context, with examples of the likelihood that innovations will be disruptive, depending on the level of regulation in the industry and what type of product the innovation offers.

![Christensen's Disruptive Innovations matrix](source: Lasher, 2010)

This literature on types of innovation and the analysis in figure 25 is important to this study, as it guides analysis on how AR should be developed and whether it is likely to become mainstream.

**How innovations spread**

Innovations spread or are taken up by markets through ‘adoption’ or ‘diffusion’; terms which are used somewhat synonymously. Rogers (2009) defines diffusion of innovations as:

‘the process in which an innovation is communicated through certain channels over time among the members of a social system.’

The adoption of innovations is based on the ‘Technological S curves’ concept, where innovations follow a life cycle of adoption over time.
This s-curve concept relates to the Museum technology lifecycle diagram in figure 24, where AR is low on the s-curve at the early stages of ‘commitment’.

Over time, technologies progress along their ‘S-curve’, with the rate of progression determined by a number of factors, including how rapidly information and awareness of the technology spreads among users.

This spread of information takes place through ‘communication channels’. The importance of ‘communication channels’ in the adoption of innovations is highlighted by many authors (Christensen, 1997; Moore, 2006; Rogers, 2009). Channels are defined as ‘the means by which messages get from one individual to another’ (Rogers, 2009) and include mass media, interpersonal communications channels, or organisations.

Communication channels are highly important to this study, as they greatly affect the adoption of an innovation, including the adoption of AR by museums and galleries.
**Different groups adopt innovations at different rates**

A wide body of research has been undertaken on the relative propensity of different groups of consumers to adopt innovations.

Following Roger’s work of the 1950s, there is now one generally accepted set of categories for consumers’ rate of innovation adoption (Rogers, 2009). Figure 27 sets out the categories of adopter. Categories are position on a standard bell curve – it is assumed that all adopters fit within a normal distribution.

![Rogers Adoption / Innovation Curve](image)

*Figure 27 – The adoption of innovation curve. Source: Value Based Management.*

There is some debate about whether the categories of adopters are continuous, as described by Rogers (2009). Or whether there are gaps between categories, with different types of consumer in each segment. The latter viewpoint is the position taken by Moore (2006), who argues that there is a particularly large gap between the ‘early adopters’ and the ‘early majority’. Moore cites examples showing that this ‘Chasm’ between the two groups can be difficult to cross for new innovations – largely because the buying habits of the two groups are very different.

However in the latest edition of his ‘Diffusion of Innovations’ book, Rogers (2009, p. 282), argues against such ‘Chasms’, stating that:

> ‘innovativeness, if measured properly, is a continuous variable and there are no sharp breaks or discontinuities between adjacent adopter categories.’
Figure 28 shows how Moore sees the innovation adoption curve.

![Figure 28](image)

**Figure 28 – Moore’s Technology Adoption Lifecycle, with a ‘Chasm’ between adopter groups. Source: Direct Impact Now, 2010.**

The initial ‘innovators’ and ‘early adopters’ are similar in some respects; they both actively look for new innovations and are prepared to make relatively risky purchasing decisions, often committing before innovations are proven. They have a vision for the innovation and take pride in being the first (Moore, 2006).

On the other side of the ‘Chasm’, the ‘early majority’ are pragmatic buyers, for whom reliability, reference customers and proven results are more important (Moore, 2006).

This ‘Chasm’ between early adopters and the early majority is a key consideration of this study. Adoption of an innovation by the ‘early majority’ indicates that it has become mainstream.

The difference in opinion between Moore and Rogers on the existence of a ‘Chasm’ is significant for this study. If such ‘Chasms’ do exist, then the adoption of AR by museums and galleries is likely occur with a relatively large step between one type of buyer and the other, only taking place once AR is sufficiently proven.

On the other hand, if adopter categories are continuous, the adoption of AR could be a gradual process, with AR moving up a more continuous curve as the ‘early adopter’ gradually merges into the ‘early majority’ consumer. The implication may
be that adoption of AR by the mainstream could proceed by AR overcoming a number of small barriers, rather than overcoming barriers in one large jump.

Moore uses a ‘Competitive-Positioning Compass’ – shown in figure 29 - to identify and assess how an innovation progress from an early ‘technology’ to a ‘product’, before crossing the chasm to the ‘market’. This model is considered a guiding tool for analysis of AR’s progress through the various stages of innovation adoption.

Figure 29 – The ‘Competitive-Positioning Compass’. Source: Moore, 2006.
What affects the rate of adoption of an innovation?

Rogers (2009) highlights that rates of adoption of innovations can be explained by their ‘characteristics, as perceived by individuals’. Characteristics of an innovation include:

- **Relative advantage** – of one innovation over another, or an existing product. May just be perceived rather than real advantage;
- **Compatibility** – with the existing values, past experiences and needs of potential adopters;
- **Complexity** – how easy the innovation is to understand and use;
- **Trialability** – being able to ‘try before buying’ helps adoption; and
- **Observability** – whether the results of adoption are visible to others.

These points are supported by Dodgson et al (2008) who highlight that for an innovation to be successful it must have the right characteristics to compete with and win over existing products or services.

For this study the innovation literature provides frameworks and models to assess the characteristics of AR and its likely impact against other technologies.

The importance of innovation decisions and organisations

Where innovations have an advantage, adopting consumers must make a range of innovation-decisions.

The literature notes that in some cases individuals decide to adopt innovations; while in others it is organisations that take the innovation adoption decision (Dodgson et al, 2008; Rogers, 2009). For this study, the innovation decisions of both individuals and organisations must be considered.

Some decisions about whether to adopt an innovation are taken purely by individuals. Such ‘optional innovation-decisions’ do not depend on the choices of others.

However, as in the case of the use of AR in museums and galleries, a decision will first be taken by the organisation on whether or not to implement AR. It is only after
this ‘authority innovation-decision’ has taken place that an individual visitor can choose to adopt. Rogers (2009) describes such situations as ‘contingent innovation-decisions’.

These contingent ‘authority innovation-decisions’ highlight the importance of organisations in the rate of adoption of AR in museums and galleries. This is particularly important as Rogers (2009) notes that:

‘innovations requiring an individual-optional innovation-decision are generally adopted more rapidly than when an innovation is adopted by an organisation’.

There appear to be few studies using innovation diffusion models to track uptake of a new technology. Dorner (2009) is a seemingly rare example of innovation models being used to assess ‘Public sector readiness for digital preservation in New Zealand’.

The lack of literature available to guide this study on innovation models and the importance of organisations is a limitation.

Innovation in museums and galleries

The literature on the processes of innovation adoption and management in museums and galleries is not extensive. This is highlighted as an area that is a limitation for this study, and an area of potential further study.

Of the limited literature specifically related to museums and galleries, a study of note was undertaken by Camarero and Garrido (2008), which highlighted that museums performed better where they have a higher level of innovation. Another paper by the same authors (Garrido and Camarero, 2010) further supports the importance of innovation in museums to improve performance:

‘Product innovation, technological innovation and organizational innovations are the key to helping cultural organizations achieve their social mission and achieve efficiency.’
Across the wider cultural and non-profit sectors there is more extensive literature on innovation and its effects on organisational performance.

McDonald (2007), for example, highlights that innovations can help non-profits improve delivery of their objectives. Although based on studies of hospitals in the US, Mcdonald’s work guides this study by identifying the importance of organisations articulating a clear mission. A clear mission is shown to make implementation of innovations more effective, increasing the positive impact innovation can have on delivery of organisational objectives.

Hull and Lio (2006) explore the differences in innovation adoption between non-profit and for-profit organisations. Their ‘three-point model for the analysis of organizational structure and decision making practices focuses on an organization’s vision, strategic constraints and financial constraints’ (Hull and Lio, 2006). An important finding for this study - particularly on the likelihood of museums and galleries in adopting new technologies - is that:

‘non-profits tend to be significantly more risk-averse than for-profit organizations, due to such factors as their more complex structure of responsibility. This, in combination with the other structural and policy differences between non-profits and for-profits, guides non-profits away from the innovation path more typically followed by for-profits.’

(Hull and Lio, 2006)

More specific guidance from the literature comes from a study by Voss et al (2006) on innovations in the professional theatre industry. Their study highlights the importance of ensuring that innovations and marketing strategies are aligned with the characteristics of the external market:

‘market sophistication moderates the impact of a firm’s product portfolio innovativeness on firm revenues, such that the relationship is more (less) positive in markets that are characterized as more (less) sophisticated’

(Voss et al, 2006)

The work of Voss et al suggests that the success of an individual organisation’s adoption of AR should be viewed within the context of activities of the wider museums and galleries sector. The wider museums and galleries sector is usually
characterised as a ‘less sophisticated’ market, implying that the impact of an innovation adopted by a museum or gallery is likely to be lower than in other sectors. In the context of this study, Voss et al’s work can be used to consider whether museums or galleries, or other more sophisticated markets, should be first to adopt innovations such as AR.
4. METHODOLOGY

4.1. Research methodology

This study uses a mixed methods embedded QUAL -> quan single study data gathering research methodology (Creswell and Plano Clark, 2007).

Mixed methods research uses both qualitative and quantitative data and can ‘provide researchers, across research disciplines, with a rigorous approach to answering their research questions’ (Creswell and Plano Clark, 2007). A case study approach was considered, however as noted by Yin (2009) ‘mixed methods research can enable you to address broader or more complicated research questions than case studies alone.’

In emerging study areas - such as the focus of this study – there is often relatively little quantitative data available, and expert qualitative opinion is an important barometer of future developments. The use of only quantitative or qualitative data would fail to build a robust picture. As Creswell and Plano Clark (2007) note, ‘by mixing the datasets, the researcher provides a better understanding of the problem than if either dataset had been used alone.’

The chosen methodology requires qualitative and quantitative data to be mixed. This study adopts the ‘Embedded Design’ approach, where quantitative data supports data and conclusions drawn from the qualitative data.

![Figure 30 – Embedded QUAL(quan) single study design. Source: Creswell and Plano Clark, 2007.](image)
4.2. Data Collection

Primary data collection and subsequent analysis was carried out concurrently.

4.2.1. Qualitative primary data

Interviews

Qualitative data was gathered through semi-structured telephone and face-to-face interviews with 16 industry experts, and from 4 presentations at the Tate ‘Museums and Mobiles in the Age of Social Media’ symposium on 7 September 2010 (hereafter both sets referred to as ‘interviewees’). A list of interviewees is at appendix 8.1.

Interviewees were chosen to represent three categories of relevance to this study:

- Museums and galleries – the ‘organisations’;
- Suppliers and designers – those building or selling AR and other digital technologies; and
- Consultants and Researchers – those active in the sector.

Semi-structured interviews took place between July – November 2010 based on a series of questions relevant to the interviewee’s area of expertise. Questions were asked to probe and clarify responses from earlier interviews and emerging findings. Interviewees were asked about the sector as a whole; it should be noted that some responses therefore reflect how interviewees think the sector perceives issues, rather than interviewees’ personal beliefs.

Notes were taken during interviews; transcribed in bullet point form; and verified with interviewees. Key points were coded and a long-list of recurring or important themes was extracted. A condensed set of 38 over-arching themes were extracted, and then grouped into 6 key areas under 3 headings (Creswell and Plano Clark, 2007; Maylor and Blackmon, 2005; Saunders et al, 2009; Yin, 2009). Results are at appendix 8.2.
Grouping of views under the three categories of interviewee was carried out for simplicity of presentation and to retain anonymity of some respondents.

In addition to the interviewees, less formal email and face-to-face contact with more than 20 other experts and organisations across the three categories was used to build a fuller understanding of the sector, trends and key issues.

Qualitative interviews can help build a deeper understanding of issues and trends. However it is acknowledged that this data gathering technique has limitations including interviewer and interviewee bias; interpretation bias; interviewee limitations on understanding of the subject; and limitations on what interviewees are able and willing to report. These issues are noted and considered common to most forms of qualitative interview research (Maylor and Blackmon, 2005; Jankowicz, 2005; Saunders et al, 2009).

On-site observational study

Further qualitative data was captured through an ethnographic observation study of users of an AR exhibition at the At-Bristol science centre. The method was chosen as it allowed for evidence to be gathered on how visitors actually use an exhibition, capturing information in a non-intrusive manner. Results are presented at appendix 8.5.

4.2.2. Quantitative primary data

Online questionnaire

An online questionnaire was created to capture data on:

- How well current digital technology enhances the visitor experience;
- An organisation’s readiness for adoption of innovation; and
- Levels of knowledge of AR and perceived value for visitors.

Questions were written based on this study’s research questions and an initial review of the literature on analytical models for innovation-adoption from – in order of importance - Rogers, 2009; Klein, 2006; and Damanpour, 1991.
A draft was tested with industry contacts and refined following feedback. The questionnaire was sent directly to over 20 named contacts at institutions in Europe and the USA; posted on the JISC Visitor Studies Group mailing list, which has 135 international members (JISC, 2010a); and linked from the September issue of the Museums Education Monitor, an international newsletter with over 400 subscribers (Castle, 2010).

A copy of the questionnaire is at appendix 8.4 and a list of the 21 responding organisations is at appendix 8.3.

It is noted that data from the questionnaire is not statistically robust, due to the relatively low number of respondents. Although identified as quantitative primary data, the findings should be used as indicative of certain viewpoints, and therefore more qualitative in nature. It is noted that as with most questionnaires, the data gathered is dependent on the understanding and knowledge of the respondent; and may not necessarily be representative of the organisation as a whole.

On-site visitor questionnaire

Primary visitor experience research was undertaken on an AR experience at the Iron Age Museum in Andover, England. Visitors tried the AR experience before completing a paper-based questionnaire at the end of the visit (copy at appendix 8.7).

A questionnaire approach was taken to elicit first hand user data and for the opportunity to interact with visitors to explore key points in more detail. Local press coverage of the AR experience, generated by this study, resulted in some additional visits, however a small sample size of 14 means that results are used as indicative, rather than statistically robust. Results are presented at appendix 8.6.
5. DATA ANALYSIS AND DISCUSSION

Following this study’s mixed methods embedded design methodology, primary and secondary data are set out and the implications and findings are then discussed.

Primary data from interviewees highlighted six key areas, which are grouped under three headings. These headings align with the stages of an innovation’s adoption defined in Moore’s ‘Competitive-Positioning Compass’ (2006), shown in figure 31.

The heading titles act as a high-level summary of the conclusions from each area.

5.1 TECHNOLOGY: Despite technological advancements in AR some issues persist; but costs are falling:
   - Technology issues;
   - Costs.

5.2 PRODUCT: a structured design process should be considered; AR can add value to a visit:
   - AR should be considered as part of a structured design process;
   - When can AR add value?

5.3 MARKET: Innovation can help build competitive advantage; organisations are not set up for innovation:
   - Innovation’s role in building competitive advantage;
   - Organisations are not set up to adopt innovation.
Figure 31 – Data presentation and discussion guided by Moore’s ‘Competitive-Positioning Compass’. Source: Moore, 2006.
5.1. TECHNOLOGY: despite technological advancements in AR some issues persist; but costs are falling

Important for any innovation to become mainstream is technology that works and is seen as delivering value for its users at justifiable cost. The first section of results sets out the findings on AR as a technology and its costs.

5.1.1. Technology and issues

Evidence on technology advancement and issues

Qualitative evidence from interviewees indicated a number of issues with technology for marker-less AR consumer technology for use on-site:

- AR technology often doesn’t work and is not sufficiently intuitive for use;
- AR currently limited by smartphone penetration, multiplicity of mobile operating systems and difficulties with on-site device connectivity;
- Some visitors like to use their own devices, while others prefer hardware provided by the organisation;
- AR is most effective when using technology for location awareness and image recognition together to enhance context and navigation; and
- Younger generations are more adept at using digital and AR tools, but older generations should not be ignored as they too can use, if implementations are well designed.

In addition to qualitative interviews, primary research carried out at Andover’s Museum of the Iron Age (appendix 8.6) and At-Bristol science centre (appendix 8.5) supports interviewees’ points that AR often does not function as intended and is not intuitive to use.

Among the range of points raised by interviewees, there were opposing views on the technical implementation of on-site consumer technology to deliver AR.

On one side: the view that organisations should develop bespoke solutions and provide devices for visitors. On the other: organisations should take advantage of
AR platforms developed and used by other sectors and rely on delivery through visitors’ own devices. Figure 32 shows the opposing viewpoints in diagram form.

![Figure 32 - Analysis of differing views on options for implementing AR technology in museums and galleries](image)

*Figure 32 – Analysis of differing views on options for implementing AR technology. Source: primary research*

Quotes from interviewees illustrating the opposing viewpoints are shown in table 1, highlighting that there is no agreed technical ‘best practice’ approach for a museum or gallery to implement AR.
### Table 1 - Opposing views from interviewees on technological implementation.

<table>
<thead>
<tr>
<th>Bespoke solutions and organisation owned hardware</th>
<th>Existing platforms and visitors’ own hardware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult to produce content and make it available on a range of mobile platforms. <em>Louisa Matthews, Acoustiguide</em></td>
<td>Can use existing platforms and toolkits to get going with AR quickly and relatively simply. <em>Marcus Winter, Brighton University</em></td>
</tr>
<tr>
<td>Device compatibility an issue; museums’ worries about technology puts some off due to lack of understanding. <em>Tim Luft, Serious Games Institute</em></td>
<td>The best applications are often delivered using existing platforms - so could use Layar, for example, to improve delivery as well as reducing costs. <em>Loic Tallon, Pocket Proof (2010a)</em></td>
</tr>
<tr>
<td>More visitors now would prefer to use their own device; but still lots who want to use one provided by the museum. <em>Matthew Petrie, Fusion + Analytics</em></td>
<td>Visitors preferred their own devices, but with lower levels of support. <em>Ted Forbes, Dallas Museum of Modern Art</em></td>
</tr>
<tr>
<td>Technology platforms (smart phones and webcams) not ubiquitous yet - so limits uptake. <em>Nicole Yershon, Ogilvy</em></td>
<td>Should use existing platforms (Blinkster) to lower cost of entry. <em>Tim Luft, Serious Games Institute</em></td>
</tr>
<tr>
<td>Unless it becomes part of a formal tour system where the equipment is given out then it is the sort of technology that can only be made use of by people with the right equipment who have thought to download in advance. <em>Gail Durbin, Head of V&amp;A Online</em></td>
<td></td>
</tr>
</tbody>
</table>

A range of supporting secondary data was collected to elaborate findings from interviewees. Data illustrating views related to the vertical axis – hardware – is set out; followed by data on the horizontal – software platforms - axis.
Hardware axis

The increasing power of internet-connected mobile devices – particularly smartphones - and their market penetration is likely to influence how organisations are able to implement on-site AR.

Smartphone sales have seen a 96% increase from Q3 2009 to Q3 2010 (Gartner, 2010b) and high sales of smartphones are predicted to continue. 28% of the UK’s 48.5 million mobile phones are smartphones (Dredge, 2010). This increasing penetration of smartphones, along with increased sales of other internet-connected mobile devices, will lead to more people accessing the internet on a mobile device, rather than using a desktop computer by 2014.

![Mobile Vs Desktop internet users](image)

*Figure 33 – Mobile Vs Desktop internet users. Source: Morgan Stanley, 2010*

As smartphone penetration increases, more visitors are likely to be willing to use their own devices to access tour guides on-site at museums and galleries. Data from Fusion + Analytics shown in figure 34 supports the view that visitors will increasingly want to use their own devices to access digital experiences, potentially including AR.
Figure 34 – Mobile device preferences among museum visitors. Source: Petrie, 2010.

Data on increased device penetration, coupled with visitors’ willingness to use their own device, suggests that delivery of AR through visitors’ own devices may be the chosen technical approach in future.

However, increased penetration and visitors’ willingness to use their own devices will not necessarily resolve the difficulties in technical approach for two reasons.

Firstly, organisations will still face technical and financial difficulties in delivering AR and other mobile applications that need to run on the many software operating systems in existence. Figure 35 highlights the range of mobile operating systems available, demonstrating that there is no single standard.
The limiting factor of multiple operating systems does not seem likely to be overcome in the short-term, creating a barrier for use of AR on visitors’ own devices.

Secondly, there are a number of technically difficult issues for museums to overcome in being able to provide device connectivity within buildings. As summarised by the Horizon museums report, some organisations:

‘are located within buildings that simply were not designed to provide the radio frequency transparency that wireless technologies require, and thus find themselves shut out of many potential technology options.’

(Johnson et al, 2010b)

The issues of connectivity mean that marker-less consumer technology AR applications may be difficult to realise, whether on devices provided by the organisation, or on visitors’ own devices.
A further issue of relying on delivery through visitors’ own devices are the potentially high fees for downloading content onto a mobile device. This is particularly acute for foreign visitors who have not downloaded the application before their visit.

Finally, it should be recognised that many organisations are accustomed to a business model where they provide and manage hardware for visitor tours. Breaking away from a tried, tested and known model may be difficult, particularly when alternatives come with a number of significant technological issues.

It is not clear at present what the eventual ‘best practice’ technical hardware approach will be. This study concludes that a mixed approach is likely, where organisations provide some devices on-site, while also making applications available to run on visitors’ own devices.

**Software platforms axis**

Some interviewees noted the potential for museums and galleries to make use of existing software platforms in delivering marker-less consumer technology AR experiences – for example Layar, Wikitude, Blinkster. Other interviewees considered it necessary for organisations to use bespoke platforms to support AR.

There is little quantitative data available to guide analysis on the question of using bespoke Vs existing software platforms.

However, it is considered important that during the course of this study a number of significant investments were made in AR platforms. One specific example is $14 million of funding raised by Layar (an AR browser) for continued development of their AR platform (Telecompaper, 2010).

This and other similar investments in AR technology (i.e. by Qualcomm and Google) suggest that development of existing and openly available platforms for AR may drive the technology and offer an approach for museums and galleries.

The evidence presented focuses on marker-less consumer technology AR uses on-site. Interviewees did not raise any significant technological issues affecting the use of marker-based AR on- or off-site, or professional technology AR.
Discussion on technology issues

There are clearly a number of major technical issues that must be overcome in order for the use of marker-less consumer technology AR on-site at museums and galleries to become mainstream. The specific issues for museums and galleries are likely to be around device connectivity and the need to support multiple software operating systems.

This study has shown that there is no agreed ‘best practice’ for implementation. This lack of ‘best practice’ and agreed standards for defining and implementing AR may hold back adoption. As Chris Cameron (2010) notes,

‘major technology players are considering AR experiences, and a lack of standards may temporarily keep them from adopting the technology.’

If major players may be put off, then less technically proficient organisations such as museums and galleries are likely to be too. The existence of opposing viewpoints on how to technically deliver AR and worries about the quality of applications is likely to be a barrier for pragmatic ‘early majority’ buyers.

The data suggests that investments in other sectors and increased smartphone penetration will drive improvement in the technical capabilities of on-site consumer technology AR use at museums and galleries. As noted by Johnson et al (2010b):

‘Emerging augmented reality tools to date have been mainly designed for marketing, social purposes, amusement, or location-based information, but new ones continue to appear as the technology becomes more popular. Augmented reality has become simple, and is now poised to enter the mainstream in the consumer sector.’

Use of marker-less AR in commercial sectors is predicted to become mainstream in the 1 - 2 year timeframe. Part of the increased uptake will be driven by increasing numbers of supporting products, developers and applications being made available.

These supporting and additional products will encourage development of what Moore (2006) calls the ‘Whole Product’, which will deliver greater value for buyers
and users of AR, while providing more pragmatic buyers with confidence that their solutions will be well supported.

![Figure 36 – The 'Whole Product' concept. Source: Moore, 2006](image)

Part of delivering the ‘Whole Product’ relies on the AR industry creating the required applications, products and services to support users, providing the ‘augmented product’ that many buyers expect to be available.

AR commentators believe that the industry is at a critical juncture where it needs to think more strategically about the ‘Whole Product’. As Bruce Sterling – a renowned AR and digital commentator - put it at the 2010 Augmented Reality Event (ARE), current work is often aimed at ‘coding apps for the early adopters of smartphones’. Sterling believes that AR professionals must think of themselves as the ‘first pure play experience designers’ (Sterling, 2010), which will help widen their thinking to strategically create the ‘Whole Product’.

This study predicts that the technological hardware and platform issues for AR in museums and galleries will be overcome in the 2 - 4 year timeframe. ‘Best practice’ for on-site delivery of consumer technology marker-less AR is likely to be based on platforms and applications developed in more sophisticated commercial sectors, then used by museums and galleries once developed.
For professional technology AR, the technology seems already to be proven. There are fewer technical barriers for static exhibits, which could become mainstream more quickly than consumer technology AR. Professional technology AR can provide engaging individual and group experiences, and appears to be sufficiently developed to deliver visitor value in certain applications. As described in the following section, costs are falling rapidly.

This study predicts a proliferation of focused professional technology AR exhibits over the next 12 – 24 months. However, although the rate of growth may be large, absolute numbers of exhibits are likely to remain low. The high growth may mean that some ‘early majority’ organisations take-up professional technology AR, meaning the innovation may, in these cases, ‘Cross the Chasm’.

There appear to be fewer technical barriers to use of marker-based AR. From a technical perspective it seems marker-based AR is sufficiently developed for many consumer technology uses on- or off-site.
5.1.2. The costs of AR are reducing

Evidence on the costs of AR

The cost of both professional and consumer technology AR was highlighted by interviewees as an important factor in adoption of AR. There were opposing views, with some perceiving the cost as high; while others believing new platforms could be used to deliver low-cost solutions.

Those considering AR to be high cost usually focused on the need for an organisation to create a bespoke software system, with new content. On the other side, interviewees saw the potential to deliver low-cost applications by ‘piggy backing’ on AR software platforms that have been developed in commercial sectors, and repurposing existing content to keep costs low.

Opinions were also split on whether or not AR applications are likely to provide a revenue stream for museums and galleries. Opposing viewpoints are shown on the diagram in figure 37.

![Diagram](image)

Figure 37 – Different views on the cost of AR. Source: primary research.
Quotes highlighting the opposing viewpoints are drawn out in table 2.

**Table 2 – Opposing viewpoints on the cost of implementing AR.**

<table>
<thead>
<tr>
<th>High cost, won’t make money</th>
<th>Low cost, could make money</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not many approaches from museums sector as AR is perceived as expensive – this is not necessarily the case. <em>Lisa Murphy, Metaio, USA</em></td>
<td>Use existing content and what’s available on the web, in addition to visitors’ own devices and common platforms to create a low cost experience, which could make money. <em>Interviewee, Consultant/Researcher</em></td>
</tr>
<tr>
<td>Museums should not consider AR or mobile apps as revenue generators. <em>Nancy Procter, Smithsonian, USA</em></td>
<td>AR will generate revenue for museums in future. <em>Margriet Schavemaker, Stedelijk Museum, Holland</em></td>
</tr>
<tr>
<td>Perceived as a high cost of implementation by some cultural organisations. <em>Becky Schutt, Cultural Consultant, UK</em></td>
<td>Costs dropping significantly, particularly with open platforms that provide low cost entry option. <em>Tim Luft, Serious Games Institute, UK</em></td>
</tr>
<tr>
<td>Costly to design and produce content, and to provide hardware onsite. Costs need to drop to stimulate uptake. <em>Louisa Matthews, Acoustiguide, UK</em></td>
<td>Costs of AR are reducing significantly. <em>Marcus Winter, Brighton University, UK</em></td>
</tr>
</tbody>
</table>

Secondary data was collected to explore the opposing points on cost of AR. Evidence supplied anonymously on the costs of AR is shown in figure 38. The data demonstrates that for consumer as well as professional technology AR, costs on a like-for-like basis have reduced by a factor of 10 over the last 3 years.
Discussion on the costs of AR

The opposing viewpoints on the cost of AR are important when considering the likely take-up of the technology.

A barrier to use of a new innovation is often the cost – perceived or actual. The data suggests that costs of professional and consumer technology AR are significantly dropping. However, two points should be noted.

Firstly, the perceived cost is seen as high. Whether the costs are high or not, perception is a driver in a consumer’s adoption of a new technology. Some organisations many not consider use of AR until well-publicised cases break the perception of high cost, by demonstrating that costs are low.

Secondly, the cost is not only the initial cost of creating an AR experience and its content. The total cost to the organisation may include indirect or secondary costs of design, implementation, support and operations, as well as the bureaucratic cost overhead in planning and delivering an AR project.
The total cost of AR must be considered and evaluated against those of other digital technologies. The total costs of AR appear to be perceived as being higher than those for other digital technologies. Assessment of whether the total cost of AR is higher or lower than other options is an area of possible further work.

These points relate to the ‘Whole Product’ concept discussed in section 5.1.1; total costs are likely to fall as the ‘Whole Product’ is built out.

The key finding from the data is that the perceived high cost of AR, both professional and consumer technology, is likely to hold back adoption of AR by museums and galleries in the short-term.

Based on the data collected, this study concludes that cost should not necessarily be viewed by museums and galleries as an immediate barrier. Using available platforms and repurposing existing content could, in certain consumer technology cases, allow organisations to create AR applications that can generate significant visitor value, for relatively small investments.

For professional technology, the costs already appear to have dropped sufficiently for the hardware to be affordable; the key is creation of compelling content to deliver visitor value.
5.2. PRODUCT: a structured design process should be considered; AR can add value to a visit

Following creation of ‘technology’, an innovation’s next stage of development is to become a ‘product’. The ‘product’ can be assessed alongside competing technologies, and areas of value creation can be identified (Moore, 2006). The second section of results presents findings relating to how and where AR ‘products’ can deliver value.

5.2.1. AR should be considered as part of a structured design process

Evidence on how AR should be considered as part of a structured design process

Interviewees identified a number of important themes around how museums and galleries should consider use of AR as part of a structured design process.

The most important theme, which received maximum support from all categories of interviewee, was that:

- Organisations should start with the problem or visitor issue, not a technology solution. AR should not be the starting point; it should only be used if after careful consideration and assessment of all technologies, it offers the best solution to provide visitor value.

Further themes from qualitative research were:

- High quality content is at the core of offering value to visitors;
- During assessment of technologies to deliver new visitor experiences, organisations should remember that non-AR applications can deliver equivalent or greater visitor value; and
- AR, as with any mobile application, should be a part of an integrated digital offer.

Secondary data from Pocket-Proof is presented in figure 39 to support interviewee’s points around the importance of high quality content in creating a valuable and
enjoyable experience for visitors. Museum management recognise that creation and maintenance of high quality content for mobile tour guides is one of their key challenges.

This data is presented, as many of the challenges of designing and implementing AR will be similar to those faced when implementing a non-AR mobile application.

![Museums' Challenges with mobile tools](image)

Figure 39 – Challenges to mobile tour guide development. Source: Tallon, 2010b.

**Discussion on how AR should be considered as part of a structured design process**

A structured design process

The evidence highlighted that the process of choosing to use AR is very important. Interviewees highlighted that there are often many routes that could be taken to deliver visitor value, or overcome a particular issue or problem.

The evidence suggests that museums and galleries could enhance decision making and maximise the effectiveness of chosen solutions by following a structured design
process. A process could help organisations fully consider the options available, before deciding to use AR or any other technology. A structured design process could ensure that organisations start with what interviewees defined as critical: creation of visitor value; and a focus on the issue or problem being addressed.

This study finds that the use of a design process such as the Design Councils’ ‘double diamond’ approach could assist organisations in fully considering their options.

Use of a design process, as set out in figure 40, could help guide organisations away from starting with AR as the technical solution. The process would prompt museums and galleries to start with the core issues and how to create visitor value, only choosing AR if it presents the best approach.

This conclusion is supported by industry experts, who believe that a more rigorous design process will help improve successful implementation of digital tools:

‘it's not the design features that are the commonality between mobile projects that make an impact, it is the way the project was approached, managed and delivered.’

(Tallon, 2010b)
Visitor segmentation

As part of a design process, organisations should understand and segment their visitors. Segmentation information should – and in many cases already is – collected and used in the design and delivery of exhibitions and applications.

Understanding and segmenting visitors is an integral part of creating experiences that deliver value, by allowing exhibits to be tailored and targeted at particular segments.

Segmentation usually follows demographic categories (age, socio-economic group etc.). However, organisations could also consider segmentation using Roger’s
categories of consumer groups’ adoption of innovation, described in the Literature Review (Rogers, 2009).

Such innovation-segmentation would help organisations understand how likely their visitors are to make use of new innovations, particularly new digital technologies. This is particularly important as adoption of innovation does not necessarily correlate with demographic segmentation.

Evidence from interviewees suggests that organisations could benefit from development of greater data collection and analysis in order to segment visitors. A deeper understanding of visitor types and their expected take-up of innovative new exhibits and applications may help organisations to better design and deliver new exhibits and experiences.

The innovation-segmentation referred to above relates to visitors’ likelihood to use new innovations once they are in place, being a useful design and marketing guide. However, with such segmentation does not refer to the ‘unit of adoption’, which is discussed in section 5.3.1.
5.2.2. When can AR add value to a museum or gallery visit?

Evidence on when can AR add value to a museum or gallery visit?

Interviewees were asked to identify where and how AR adds value to a visit. The key themes highlighted were similar to the seven value areas identified in the Literature Review, as shown in table 3. This covers both consumer and professional technology AR.

Table 3 – AR value areas identified by literature and interviewees.

<table>
<thead>
<tr>
<th>Areas where AR adds value</th>
<th>Literature Review</th>
<th>Interviewees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalisation of visits</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Making things possible that are otherwise not possible</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Enhancing the context of objects or spaces</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Providing an interactive, hands-on experience</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Engaging group interaction</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>An enjoyable, entertaining and new experience</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Assisting navigation and exploration</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

The value areas could be used as part of a structured design process, referred to in section 5.2.1, to guide decisions on how and where AR could be implemented effectively.

Further primary evidence was collected through an online questionnaire, which asked respondents how well they thought existing digital technologies and AR deliver value to their visitors.

The results in figure 41 suggest that across all areas of visitor value, organisations perceived that AR could deliver greater value than other digital technologies. The
areas of value map with those highlighted in table 3 around enhancing context, interaction, participation and enjoyment.

![Perceived value for museum visitor provided by digital technologies Vs AR](image)

*Figure 41: Perceived value for museum visitors provided by digital technologies Vs AR. (0 = low value, 5 = high value) Source: primary research questionnaire.*

Additional primary and secondary data in appendix 8.9 provides further evidence to support the findings that organisations believe that AR could deliver greater value and be used by a greater proportion of visitors than existing digital technologies.

Further evidence that AR can deliver value in key learning areas for museums and galleries is shown on figure 42, based on Hawker’s (2004) taxonomy of museum learning opportunities with digital technologies. Icons have been added to show how different forms of AR can be used to add value to most museum learning opportunities. Where icons appear alongside a higher level ‘learning opportunity’ this means those icons are relevant for all lower level ‘opportunities’ in that area.
Discussion on when can AR add value to a museum or gallery visit?

The data suggests that AR can add value in a number of value areas for visitors to museums and galleries. The areas map against those considered by museums and galleries to be important in delivering their aims and objectives.

The evidence suggests that AR, if well implemented, has the potential to offer greater value than current digital technologies. The key is high quality implementation of either consumer or professional technology AR, with a clear focus on delivery of visitor value through well-designed usability, robust technology and high quality content.

The potential to deliver visitor value is one important characteristic of AR, which could confer ‘relative advantage’ on AR when compared with existing digital technologies (Rogers, 2009). The likelihood of an innovation being adopted depends on a number of characteristics defined by Rogers, and discussed in figure 4.
Adoption relies on the innovation’s characteristics, but also ‘communication channels’ and the ‘unit of adoption’, both discussed in section 5.3.

*Table 4 – Analysis of AR’s likely adoption rate against Roger’s five characteristics of innovations. Source: model from Rogers, 2009; ratings and judgement author’s own*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Notes</th>
<th>Adoption judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative advantage</td>
<td>Potential to offer enhanced visitor experiences, if implemented in the right way.</td>
<td>Good</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Can be compatible with other digital technologies in use; but AR is not a simple fit with all organisations.</td>
<td>Reasonable</td>
</tr>
<tr>
<td>Complexity</td>
<td>Perceived as being very difficult and technically complex to implement.</td>
<td>Poor</td>
</tr>
<tr>
<td>Trialability</td>
<td>Pilots can be carried out at small-scale but may be disproportionally expensive. Use of existing content and common platforms on visitors’ own hardware can make trials more viable.</td>
<td>Reasonable</td>
</tr>
<tr>
<td>Observability</td>
<td>Highly observable by other visitors when used on-site and through positive press publicity.</td>
<td>Very good</td>
</tr>
</tbody>
</table>

Table 4 highlights that AR has some, but not all, of the necessary characteristics to be an innovation adopted by the majority. Technical limitations and perceptions of high cost (see section 5.1) hold AR back, as these issues detract from its ‘relative advantages’.

AR has the potential to deliver significant value in areas important to museums and galleries, however technical and cost issues prevent widespread immediate adoption.
5.3. MARKET: Innovation can help build competitive advantage; organisations are not set up for innovation

The final area of results and discussion relates to the role of the sector and the museums and gallery organisations themselves in the adoption of innovation. Once an innovation has been technologically proven and developed into a product in the early market, it then relies on the mainstream market to be sufficiently developed and aware in order for adoption to take place.

5.3.1. Innovation’s role in building competitive advantage for museums and galleries

Evidence on innovation’s role in building competitive advantage for museums and galleries

Qualitative evidence from interviewees suggests key themes around the use of innovation to build competitive advantage in the museums and galleries sector:

- Museums and galleries exist in a competitive landscape;
- Innovation can build competitive advantage;
- Use of AR can create a ‘wow’ and positive press headlines, creating an association between the organisation and innovativeness; and
- There are few very good examples of AR in the sector, and the sector is not generally aware of AR.

Further evidence was collected to elaborate on points around AR’s ability to create a ‘wow’, and the sector’s awareness of AR.

Use of AR to create a ‘wow’

Primary research carried out at Andover’s Museum of the Iron Age (appendix 8.6) supports views that AR is able to generate a ‘wow’ with visitors. Visitors reported increased enjoyment, engagement and desire for follow-up visits, despite feeling that the technical delivery and usability of the AR experience was poor.
A limited set of quantitative data was available from organisations on the use of AR and non-AR mobile applications. The data presented below shows that AR applications can be highly successful in generating user downloads and engagement. However, balancing data on non-AR mobile applications must be noted. Non-AR applications are shown to be highly effective in terms of downloads and user engagement, as well as generation of positive publicity.

AR applications

- **Metaio virtual kiosks**: Seat AR kiosk resulted in 10% increase in membership sign ups. Source: Murphy, 2010.

Non-AR applications

- **National Trust**, mobile application: Downloaded over 350,000 times and used over 1.7 million times for an average of 7.7 minutes at a time. Source: Moore, 2010.

Organisations should be aware that although AR can be one route to generate a ‘wow’ and positive publicity, other routes may be equally or more effective in achieving these aims.

**Sector’s awareness of AR**

Of the organisations responding to this study’s online questionnaire, 25% had no knowledge of AR, while over half were either already using or considering using AR. This evidence indicates that a majority of organisations know about AR. However, there remain a large minority who are not aware of AR.

Awareness of an innovation is an important stage in its likely adoption. Before adoption can take place, organisations first must be aware of an innovation in order to consider its use.
Evidence shown in figure 44 suggests that museums and galleries have plans in place to use or consider use of AR during 2011 – 2012. Although this suggests that AR could be taken up by more organisations, it must be balanced by the data showing other digital mobile solutions are expected to be used more than AR.

Figure 43: Survey respondents’ knowledge of augmented reality. Source: primary research online questionnaire

Figure 44 – Museums and galleries’ plans for mobile during 2011 – 2012. Source: Tallon, 2010b.
Discussion on AR’s role in building competitive advantage for museums and galleries

Museums and galleries function in a competitive landscape. Organisations compete in a range of areas including for funding, philanthropy, visitors, critics and press coverage. In any competitive landscape organisations must create some form of competitive advantage over other organisations to continue to exist and prosper.

Competitive advantage is taken for this study as the ability of one organisation to sustain a superior position in relation to competitors (Grant, 2005). In the cultural sector competitive advantage is built through the provision of differentiated offers to visitors and is generally used to generate higher visitor numbers and engagement.

Figure 45 – Cultural organisations generate competitive advantage through differentiation. Source: Grant, 2005.

In an increasingly difficult financial climate, the evidence from interviewees and the Literature Review suggests that museums and galleries should become more aware of the competitive landscape in which they exist, and the need to generate and build competitive advantage.

Innovation is one way in which museums and galleries can differentiate and build competitive advantage. This is supported by literature from Cammarero and Garrido (2008), Garrido and Cammarero (2010) and Voss et al (2006) who all highlight that innovation can help museums perform better and differentiate their offer to visitors, building competitive advantage.
AR is just one technology that could be implemented by innovative organisations. The data highlights that a key outcome of AR – as well as other digital applications - is the generation of positive publicity for the implementing organisation and the creation of an association with innovativeness. Publicity and positive associations are ways that organisations can differentiate and build competitive advantage.

Publicity in the media and word-of-mouth communication of the ‘wow’ factor of AR plays a role in the diffusion of AR. As highlighted by Rogers (2009), communication channels such as the media and word-of-mouth can define and constrain the diffusion of innovations.

Anecdotal evidence that the use of AR can generate media interest and publicity came from one consultant/researcher interviewed. The interviewee recounted that an AR development company had tested the effectiveness of its Press Releases. Some Releases highlighted AR, while AR was mentioned less prominently in others. The Press Releases with AR highlighted received much greater publicity than the others, even when the products were the same.

This anecdote is useful as it suggests that AR can generate news headlines, which will increase awareness of AR and encourage diffusion.

However, as noted elsewhere in this report, a lack of standardisation is likely to hold back the diffusion of AR in the short-term. Communication channels may find it difficult to clearly identify how and where AR adds value and where it can be used. Efforts such as those by Total Immersion shown in figure 5 are therefore likely to help lower these communication barriers.

Awareness of AR in the museums and galleries sector is growing, driven by increasing publicity in other sectors; high profile and successful projects within the sector (i.e. Museum of London Streetmuseum); and extensive discussions at conferences such as the Tate Modern’s ‘Museums and Mobiles in the Age of Social Media’.

Museums and galleries’ increasing awareness, driven by AR’s effective communication channels is likely to positively affect the potential for AR to diffuse into mainstream use in the cultural sector.
Communications channels and the museum and gallery sector’s awareness of AR are discussed here as they are relevant to organisation’s potential to use AR to differentiate and generate competitive advantage.
5.3.2. Organisations are not set up to adopt innovation, including AR

Evidence that organisations are not set up to adopt innovations, including AR

The critical role of the museum or gallery organisation in adopting AR, and the difficulties those organisations face in attempting to implement new innovations was mentioned in qualitative interviews. Interviewees highlighted the following key themes:

- The whole organisation must support implementation of new technologies in order to successfully deliver;
- Support and drive from an organisation’s top leadership is crucial for success;
- Organisations may not have the right core capabilities to deliver AR; and
- Organisations should put in place an innovation strategy, which should form part of the organisation’s overall corporate strategy.

Interviewees highlighted concerns about the ability of museums and galleries to lead the adoption of new innovations such as AR. Interviewees questioned whether organisations have the right core capabilities and organisational culture (Grant, 2005) to effectively use AR.

Findings from primary research support academic papers cited in the Literature Review on the relative inability of cultural and non-profit organisations to lead adoption of innovations (Hull and Lio, 2006).

This study’s primary research questionnaire captured data on organisations’ perception of their readiness to adopt innovation. Figure 46 sets out the survey results using Klein’s matrix (1996), in full at appendix 8.8.

Organisations generally believe they have a culture that is neutral to good for values fit. Organisations also believe they have medium to strong climates for innovation.
These results should be used carefully as a number of factors affect reliability:

- Positivism bias of respondents – common in many user surveys;
- Inconsistent respondent type – respondents from different organisations may be from different parts of the organisations (i.e. IT, Visitor Services, Media and Communications etc.); and
- Relative responses – judgements are necessarily relative to the respondent’s experience and do not show an absolute picture of the sector.

Evidence shown in figure 46 suggests that museums and galleries have a good readiness for adopting innovations, which contradicts the qualitative evidence collected from interviewees and other research.

It is felt that evidence from qualitative research is more reliable as a basis for drawing the conclusion that museums and galleries do not have the optimum core capabilities or cultural fit to implement new innovations such as AR.

Part of an organisation’s readiness to change is how it is structured and how different parts of the organisation relate and work together. Hawkey (2004) makes a
particularly noteworthy comment in relation to working across departments within a museum:

‘the various functions of the museum, collections, management, exhibitions, education and website, may well be the responsibility of completely separate departments, with little inter-communication and, possibly, conflicting philosophies.’

(Hawkey, 2004)

Discussion that organisations are not set up to adopt innovations, including AR

Core competencies

As highlighted in section 5.3.1, museums and galleries exist in a competitive landscape, building competitive advantage through differentiation. The evidence in this section suggests that museums and galleries may not have the right core competencies and resources available to develop and implement new innovations, potentially including AR.

Figure 47 sets out the relationship between an organisation’s resources, capabilities and strategy to generate competitive advantage. Analysis of museums and galleries’ position is provided in italics.
Data presented in previous sections suggests that AR could deliver value to visitors and help an organisation to differentiate its visitor offer. In order for museums and galleries to use AR (and other digital technologies) successfully, the evidence suggests that additional skills and capabilities are required. These could be provided through partnering with other organisations, to bring in the additional skills to develop and implement innovations.

It is noteworthy that the highly successful Museum of London Streetmuseum application was developed with an external creative and branding agency; Brothers and Sisters. Partnering or contracting to bring in specialist skills is prevalent in many industries; the evidence suggests this is could be a route for consideration by museums and galleries.
This analysis, and industry expert opinions (Tallon, 2010b), demonstrates that museums and galleries may need to work with partners or contractors to successfully deliver. Generalisations cannot be made, and this study does not suggest that external organisations should always be used. Organisations should use their resources in the first place, because as noted by Johnson et al (2010b):

‘individual museum constraints are likely the most important factors in any decision to adopt — or not to adopt — any given technology.’

Unit of adoption of innovation

In considering the ‘unit of adoption’ (Rogers, 2009) of AR in museums and galleries, the organisation itself is the unit of adoption.

At present, visitors’ on-site use of AR depends on the organisations’ prior innovation-decision to implement AR. As such, diffusion of AR into the sector depends on uptake by museum and gallery organisations, which may have a limiting effect on the rate of adoption.

As noted in section 5.3.1, organisations do not have a high level of awareness of AR. Furthermore, as shown in this section, organisations do not generally have the core capabilities or cultural values to implement digital technological innovations.

In future it may be possible for visitors to access AR applications that are not controlled by the organisation. A recent (October 2010) example of this is an AR art exhibition at the New York Museum of Modern Art curated and created by individuals not associated with the organisation (McHugh, 2010). If such AR on-site marker-less applications become more prevalent, the unit of adoption may shift towards the visitor, which would likely increase the rate of adoption.

It is beyond the scope of this study to segment the various types of museum and gallery into innovation adoption categories. A rigorous analysis of the number of organisations in each innovation adopter category may provide the sector with useful insight into which organisations may first successfully adopt AR.

Segmentation of visitors was discussed in section 5.2.2, however it should be noted that this discussion was on segmentation for exhibition design and marketing
purposes. This is separate to discussion in this section on the unit of adoption of innovation, and the potential to segment organisations into innovation adoption categories.

**Innovation strategies**

This section concludes with a discussion of the importance of innovation strategies. This study concurs with interviewees’ points that organisations should put into place innovation strategies, which should form part of and be delivered alongside the organisation’s wider corporate strategy. The need for innovation strategies is echoed by the Horizon Report on museums:

‘Far too few museums are crafting and following a comprehensive strategy to ensure that they can keep pace with even the most proven technologies. A comprehensive digital strategy should include plans to use technology not only for learning and interpretation, but also for marketing, e-philanthropy, revenue generation, digitization, and digital preservation — as well as plans for the general technology infrastructure.’

*(Johnson et al, 2010b)*

An innovation strategy need not be long or arduous to produce. It should draw on the reality of an organisation’s resources and its capabilities and is most effective when owned and delivered by the whole organisation as part of wider corporate strategy. The strategy should fit within and be guided by a clear statement of the organisations’ mission (McDonald, 2007), which can help successful design and delivery of innovations to support an organisation’s objectives.

Development of innovation strategies could help organisations to deliver differentiated visitor offers and build competitive advantage. An innovation strategy could include reference to use of a structured design process, as set out in section 5.2.1.

AR should not be named as a specific part of the innovation strategy. However, an innovation strategy may assist adoption of AR, as AR would be robustly considered as part of a planned approach to using innovation to deliver corporate strategy.
5.4. Limitations of the research

The research findings presented are limited by a number of factors, some of which are highlighted in the methodology section.

As a new area of study, this research relies heavily on qualitative findings drawn from interviews with experts from across the sector. A necessary reliance on qualitative interviews limits the potential to base evidence and discussions on robust qualitative evidence.

As the field of study becomes more mature, it is likely that a more robust study using quantitative data would be possible.

Where possible, this study supplements qualitative data with quantitative data drawn from a variety of sources. These secondary data sources are at times necessarily from fields other than this study’s subject of research. There are limitations when using secondary data sources as proxies for evidence in a subject of study.

In addition to the limitations described above, the pace of change in the subject of study is a further limitation. As new uses and applications of AR enter the market on a weekly basis, findings and evidence gathered early in the project have already been superseded before the project has concluded. This limits the long-term relevance of some of this study’s data, as interviewees’ opinions may have already changed.
6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Overall conclusions

AR appears to have the potential to meet people’s latent needs to understand and engage with spaces, objects, information or services in an intuitive, natural manner.

Driven by its ability to deliver what people need and want, this study concludes that consumer technology AR will become a mainstream digital tool in the near future, based on marker-less applications used in commercial sectors. Marker-less AR will ‘Cross the Chasm’ in some sectors – particularly advertising, marketing and navigation – in 2011 or 2012.

Mainstream use of marker-less consumer technology on-site at museums and galleries will take place after 2012, held back by technological issues and the sector’s reluctance, and in some cases inability, to be ‘early adopters’. Prior to mainstream adoption, there are likely to be significant opportunities for museums and galleries to use marker-based AR to engage visitors off-site pre- and post-visit.

This study also concludes that there will be a growing number of professional technology AR instillations that deliver value on-site, but which will be limited to use by a relative minority of visitors.

Analysis of AR’s progress in ‘Crossing the Chasm’ is shown in figure 48 using Moore’s ‘Competitive Positioning Compass’ model. Progress in commercial sectors is identified in the columns titled ‘AR’, while specific use of consumer technology marker-less AR in museums and galleries is under ‘M&G’. 
Figure 48 – Analysis of AR’s progress in ‘Crossing the Chasm’. Source: based on model from Moore, 2006.
Before elaborating on the conclusions, the study research questions are repeated and answered in table 5. The study also concludes that a ‘Chasm’ does exist between museum and gallery organisations in the ‘early adopter’ and ‘early majority’ groups.

Table 5 – Research questions and the answers drawn from this study.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Answer / Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does augmented reality add value to a visitor’s experience?</td>
<td>Yes. Seven value areas have been identified, which are supported by interviewees.</td>
</tr>
<tr>
<td>Does augmented reality offer advantages over other digital tools used by museums and galleries?</td>
<td>In some cases. AR may offer some advantages in some areas. However, in many areas existing tools could provide equal or greater advantages.</td>
</tr>
<tr>
<td>What is the role of the museum or gallery in adoption of augmented reality?</td>
<td>The organisation is the unit of adoption; at present.</td>
</tr>
<tr>
<td>What are the current and future expectations around cost and usability of augmented reality?</td>
<td>Costs are dropping and are expected to drop further as AR is increasingly used in the commercial sector. Usability is likely to increase.</td>
</tr>
<tr>
<td>Will the use of augmented reality on-site at museums and galleries become mainstream?</td>
<td>Probably yes, but marker-less AR will lag mainstream commercial sector use by 1 – 2 years, becoming mainstream after 2012. Off-site and professional technology AR may see mainstream use sooner.</td>
</tr>
</tbody>
</table>

The conclusions are discussed in more detail below.

**Uses of AR in non-cultural sectors**

AR will first become mainstream in sectors other than museums and galleries. Gartner (2010b) predict that by 2014 in mature markets, 30% of mobile subscribers on data plans will use AR at least once a week. This suggests that AR is not yet mainstream, but will ‘Cross the Chasm’ in future.
There is a risk that an AR bubble will burst (Gartner, 2010a), as some implementations may not be delivering long-term value to end users, particularly marker-based AR which can be seen as ‘endearing toys and gimmicks’ (Sterling, 2010).

If a bubble does burst, significant investments by large companies in AR (including by Qualcomm and Google) suggests that the underlying technology will continue to evolve.

AR is not just a fad, as it is seen by some as a natural next step in mobile computing:

‘AR is just a natural evolution as computing devices get smaller, networks get faster and processing takes place in the cloud.’

(Nick Heller, Google)

This study believes that the term AR will be surpassed by a term or terms that describe more clearly the benefits to consumers of using AR.

**Uses of AR in the cultural sector**

Further conclusions on AR’s potential to become mainstream in museums and galleries are set out below, following the three headings used to present the evidence from this study.

**Technology issues and costs for museums and galleries**

Technical issues around the use of consumer technology on-site AR need to be resolved and visibly overcome before pragmatic ‘early majority’ buyers in the museums and galleries sector will invest. Perceived high costs of AR need to demonstrably reduce.

Museums and galleries do not have to overcome these issues themselves, as investment in other sectors is likely to solve the issues and lower costs. Therefore, organisations considering consumer technology marker-less applications should use
existing software platforms and rely on delivery through visitors’ own devices to reduce costs and barriers to development.

In the short-term museums and galleries can gain value from using marker-based AR for off-site use; and as costs continue to fall, organisations could develop engaging professional technology AR exhibits for use on-site. High quality content is paramount in both cases.

**Design and delivery of AR as a product**

Museums and galleries should follow a structured design process that starts with the issues an organisation wants to solve. The focus should be on visitors and content; not on a technical solution. As Nicole Yerson from Ogilvy Labs puts it, it is:

“all about people, not the technology”

A sentiment supported by Loic Tallon (2010b), Director of Pocket-Proof:

‘It’s not about the technology: it’s about the experience’

As technologies such as AR become more widely known, there is likely to be an increase in organisations wanting “to do something in AR”, similar to calls in recent years for “we need an app”. Both starting points should be rejected; the technical solution must come after a considered discovery phase.

Where AR is chosen as a viable technical solution, this study has shown that it can deliver value for visitors. As more technology supporting AR becomes available; the developer community grows; and additional AR services are added, the ‘Whole Product’ will be available to consumers, encouraging adoption.

This study concludes that standardisation and more precise definition of AR will take place during 2011 and a ‘Whole Product’ will develop around AR during 2012. This will support mainstream use in many sectors in 2011 – 2012; with museums and galleries more rapidly taking up AR after 2012.
Sector and organisational issues with adoption of AR

Museums and galleries exist in a competitive landscape and must differentiate their offer to build competitive advantage. Innovation, potentially including the use of AR, can help organisations to differentiate.

Use of AR can generate news headlines and word-of-mouth awareness of the project/exhibit and the implementing organisation. This builds competitive advantage for the organisation, as well as being a key communication channel for the diffusion of AR.

Evidence from this study suggests that AR (either consumer or professional technology implementations) will help museums and galleries generate competitive advantage in the 2 – 4 year timeframe. As technology and use of AR in other sectors becomes mainstream, this study concludes that AR in museums and galleries will become an expected part of a visit in the 4 + year timeframe.

While AR may be used to generate competitive advantage, this study concludes that museums and galleries may not have the right core capabilities to successfully design and implement AR.

Museums and galleries should consider partnering with other companies or organisations to bring in the right skills, involving partners in a structured design process.

This study also concludes that this design process should sit within a strategy for innovation, specifically setting out how the museum or gallery will assess and implement digital technologies to help deliver its aims and objectives. Organisations should develop and deliver innovation strategies as part of wider corporate strategy.

For the short-term, the organisation - rather than the individual visitor - is the unit of adoption of innovation. This limits the rate of adoption of AR.

At present, visitors’ decision to adopt AR is based on the prior authority innovation-decision taken by the organisation. This may change in the medium-term as more AR experiences are available from individuals or organisations separate from the museum or gallery.
6.2. Recommendations

The recommendations of this study are drawn from the discussions and conclusions drawn from the evidence collected. Museums and galleries should:

1. Recognise their position within a competitive landscape and the need to differentiate to generate competitive advantage;

2. Develop and deliver innovation strategies to generate competitive advantage. The innovation strategy should be aligned with wider corporate strategy;

3. Set out the requirement to use a structured design process in considering, designing and implementing projects, particularly those considering use of innovative digital technologies;

4. Focus on visitor value and the issues or problems being addressed; organisations should not design a project around use of one particular technology;

5. Increase their awareness of new technologies and how they can help deliver visitor value;

6. Consider partnering with specialists to deliver projects using new digital technologies; and

7. Regularly assess the potential to use AR, as part of a structured design process.

Finally, figure 49 sets out analysis suggesting how museums and galleries could implement AR in the short-term, avoiding the barriers that currently exist.
Figure 49 – Routes for museums and galleries to implement marker-less AR on-site.
Source: author’s own model based on conclusions from evidence.
6.3. Further work

This study has drawn together current thinking and understanding on what is a very large and fast-moving subject. As it is not possible to cover all subjects, there are a number of areas for further work:

• Investigation and development of frameworks for robust evidence gathering and analysis of mobile applications used in the cultural sector, including the need for baseline data and longer-term tracking of impacts;
• How AR could change how reality is perceived and how social conditioning affects what is ‘real’ and what is ‘virtual’;
• Exploration of changes in visitor value and what new generations of visitors to cultural institutions expect;
• Investigation of an organisation’s visitor offer and how the quality, breadth and modernity of the offer affects visitors’ perception of value - particularly in relation to new digital technologies;
• The importance and impact of innovation in delivering museum and gallery corporate strategy;
• Organisation innovation strategies and how organisations in the cultural sector can appropriately develop and realise such strategies;
• Data collection on success of AR and non-AR mobile applications;
• Assessment of whether the total cost of AR is higher or lower than other digital technologies;
• Segmentation of types of museums and galleries using Rogers’ innovation adoption categories; and
• Applications of AR at other types of visitor organisations including theme parks, conferences and exhibitions.
7. REFERENCES


Design Council (n.d.) *The Design Process* [Online] Available from:  


Durbin, Gail. Head of V&A Online. (Personal communication, 24 November 2010).

Featherstone, Helen. Content and Visitor Researcher, At-Bristol (Personal communication, 30 October 2010).


Grinsted, Tom. Head of Digital Media, Imperial War Museum (Personal communication, 27 October 2010).


Heller, Nick. Google (Personal communication, 8 October 2010).


Luft, Tim. Serious Games Institute, Coventry University (Personal communication, 21 October 2010).

Matthews, Louisa. Managing Director, Acoustiguide UK (Personal communication, 18 August 2010).


Moore, Adam. Digital Project Manager, The National Trust (Personal communication, 2 September 2010).


Murphy, Lisa. Metaio Product Marketing Manager. (Personal communication, 18 August 2010).


Petrie, Matthew. Director Fusion + Analytics. (Personal communication, 28 October 2010).


Robbins, Antony. Head of Communications, Museum of London (Personal communication, 31 August 2010).


Schutt, Becky. Cultural Consultant (Personal communication, 27 October 2010).


Tallon, Loic. Director Pocket Proof. (Personal communication, 27 October 2010a).


Terroso, Diogo. Director Near Interaction (Personal communication, 24 October 2010).


Winter, Marcus. AR Researcher, University of Brighton (Personal communication, 10 November 2010).


Yershon, Nicole. Ogilvy Labs. (Personal communication, 7 September 2010).

### 8. APPENDICIES

#### 8.1. List of qualitative interviews or conference presentations

<table>
<thead>
<tr>
<th>Category/Person</th>
<th>Organisation</th>
<th>Interview / Conference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Museums and galleries</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nancy Procter</td>
<td>Smithsonian, USA</td>
<td>C</td>
</tr>
<tr>
<td>Peter Samis</td>
<td>San Francisco Museum of Modern Art, USA</td>
<td>C</td>
</tr>
<tr>
<td>Ted Forbes</td>
<td>Dallas Museum, USA</td>
<td>C</td>
</tr>
<tr>
<td>Margriet Schavemaker</td>
<td>Stedelijk Museum, Amsterdam, Netherlands</td>
<td>I</td>
</tr>
<tr>
<td>Tom Grinsted</td>
<td>Imperial War Museum, UK</td>
<td>I</td>
</tr>
<tr>
<td>Helen Featherstone</td>
<td>At-Bristol, UK</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Suppliers/designers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Louisa Matthews</td>
<td>Acoustiguide, UK</td>
<td>I</td>
</tr>
<tr>
<td>Diogo Terroso</td>
<td>Near Interaction, Portugal</td>
<td>I</td>
</tr>
<tr>
<td>Lisa Murphy</td>
<td>Metaio, USA</td>
<td>I</td>
</tr>
<tr>
<td>Tim Luft</td>
<td>Serious Games Institute, UK</td>
<td>I</td>
</tr>
<tr>
<td>Nick Heller</td>
<td>Google, Switzerland</td>
<td>I</td>
</tr>
<tr>
<td>Nicole Yershon</td>
<td>Ogilvy Interactive, UK</td>
<td>I</td>
</tr>
<tr>
<td>James Alliban</td>
<td>Augmatic, UK</td>
<td>I</td>
</tr>
<tr>
<td>Foteini Valeonti</td>
<td>MA Ravensbourne College, UK</td>
<td>I</td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Consultants/researchers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitin Samani</td>
<td>Augmented Planet, UK</td>
<td>I</td>
</tr>
<tr>
<td>Marcus Winter</td>
<td>University of Brighton, Interactive...</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>Research Group, UK</td>
<td></td>
</tr>
<tr>
<td>Matthew Petrie</td>
<td>Fusion + Analytics, UK &amp; USA</td>
<td>I</td>
</tr>
<tr>
<td>Jason DaPonte</td>
<td>Ex-BBC, Consultant, UK</td>
<td>C</td>
</tr>
<tr>
<td>Becky Schutt</td>
<td>Cultural Consultant, UK &amp;</td>
<td>I</td>
</tr>
</tbody>
</table>
### 8.2. Appendix X – Short-list of key points from qualitative interviews

<table>
<thead>
<tr>
<th>Code</th>
<th>THEME</th>
<th>Museums and Galleries</th>
<th>Suppliers</th>
<th>Consultants and Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AR TECHNOLOGY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>AR most effective with context, location and image recognition together</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>T2</td>
<td>Younger generation use digital/AR more and more effectively</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>T3</td>
<td>Technology often doesn’t work and not intuitive (Museum of the Iron Age primary research)</td>
<td>++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>T4</td>
<td>Lots of AR is just visual search</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>T5</td>
<td>Some visitors like using own hardware, while others prefer attraction-provided (Figure X – mobile device preferences)</td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>T6</td>
<td>AR limited by mobile device penetration, connectivity difficulties and no single operating system (Figure X - mobile internet access takeup)</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>T7</td>
<td>AR effective when it mimics natural behaviours (Wojciechowski et al, 2004)</td>
<td>++</td>
<td></td>
<td>++</td>
</tr>
<tr>
<td>T8</td>
<td>Roaming charges hold back use by tourists</td>
<td>+</td>
<td></td>
<td>++</td>
</tr>
</tbody>
</table>
### COSTS OF AR

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>++</th>
<th>+</th>
<th>+++</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Use existing platforms and content to lower implementation cost</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>C2</td>
<td>Perceived high cost, but reducing (Cost of AR implementations)</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>Unlikely to make money for organisations</td>
<td>++</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>Freemium models increasingly popular</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### INCEPTION AND DESIGN OF AR PROJECTS

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>++</th>
<th>+</th>
<th>+++</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Must start with the problem, not the technological solution</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>D2</td>
<td>Quality content is key (Figure X – challenge to mobile tour guide development)</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>D3</td>
<td>Start with visitors and what is important to them (Figure X – what museum visitors value)</td>
<td>+++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>D4</td>
<td>Non-AR experiences can deliver equivalent visitor value (Figure X – perceived value for museums visitors)</td>
<td>+++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>D5</td>
<td>AR should be part of an integrated digital offer</td>
<td>++</td>
<td></td>
<td>+++</td>
</tr>
<tr>
<td>D6</td>
<td>AR must offer visitor more than otherwise available</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>D7</td>
<td>Narrative is important</td>
<td>++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D8</td>
<td>Playfulness can increase engagement</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>D9</td>
<td>Institution-specific; AR must fit with</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### IMPLEMENTATION AND VALUE OF AR PROJECTS

<table>
<thead>
<tr>
<th>Type of Exhibit</th>
<th>Value of AR Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>Can enhance the context of an exhibit or visit &lt;br&gt;(Figure X - perceived value for museums visitors)</td>
</tr>
<tr>
<td>I2</td>
<td>Can improve engagement, interaction and participation &lt;br&gt;(Figure X - perceived value for museums visitors)</td>
</tr>
<tr>
<td>I3</td>
<td>Helps increase engagement pre and post visit</td>
</tr>
<tr>
<td>I4</td>
<td>Can help visitors do things or see things that cannot be done in physical world</td>
</tr>
<tr>
<td>I5</td>
<td>Can help navigation &lt;br&gt;(Figure X – reasons visitors took an iPod museum tour)</td>
</tr>
</tbody>
</table>

### MUSEUMS AND GALLERIES SECTOR

<table>
<thead>
<tr>
<th>Type of Exhibit</th>
<th>Value of AR Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Can create a 'wow' and an association with innovativeness</td>
</tr>
<tr>
<td>S2</td>
<td>Organisations in sector must innovate for competitive advantage</td>
</tr>
<tr>
<td>S3</td>
<td>Few very good examples of AR in sector</td>
</tr>
<tr>
<td>S4</td>
<td>Sector not generally aware of AR &lt;br&gt;(Figure X – survey respondents' knowledge of AR)</td>
</tr>
<tr>
<td>S5</td>
<td>Evidence collection across sector is inconsistent and patchy</td>
</tr>
</tbody>
</table>

### ORGANISATIONAL CAPABILITIES
| O1 | Whole organisation must support to deliver (Figure X – organisational readiness to adopt innovations; and figure X 0 challenges to mobile tour development) | ++ | + | +++ |
| O2 | Top leadership support and drive is key (Figure X – organisational readiness to adopt innovations) | ++ | +++ |
| O3 | Sector may not have the right core capabilities to deliver AR (Figure X – organisational readiness to adopt innovations) | ++ |
| O4 | Can be more difficult to innovate in large cultural organisations | ++ |
| O5 | Cultural organisations should have an innovation/digital strategy | ++ |
| O6 | Bureaucracy stifles innovation | + |
| O7 | Smaller cultural organisations can implement things more quickly, but are resource constrained | + |
8.3. Quantitative survey results

List of participating organisations:

At-Bristol, UK
Acoustiguide Limited, UK
Amgueddfa Cymru - National Museum Wales
Bata Shoe Museum, Canada
Birmingham, UK
British Museum, UK
C.H. Nash Museum at Chucalissa, USA
Centre for Life, UK
Dundee Art Galleries and Museums, Dundee City Council, UK
East Lothian Council Museum Service, UK
Historic Royal Palaces, UK
Jewish Museum Berlin, Germany
The Museum of the Iron Age, Andover, UK
Museum of New Zealand Te Papa Tongarewa, New Zealand
National Gallery of Art - Washington DC, USA
National Gallery of Denmark, Denmark
Oregon State University Valley Library, USA
Powerhouse Museum, Australia
Royal Botanic Gardens Kew, UK
Royal Opera House, UK
Science Museum, UK
8.4. Online primary research questionnaire

Use of digital technologies on-site at museums and galleries

This questionnaire gathers data for use in my MBA thesis. This data is a very important part of my work - I appreciate your input.
All data will be treated confidentially and anonymised during analysis.

Section A YOUR ORGANISATION
1 Name of organisation
2 Number of employees
3 Approximate number of visitors per year
4 Please rate how important the following features are in creating value for your visitors. Please add any other features.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Not Important</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New experiences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fun/entertainment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic research</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Tourism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meeting new people</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interacting with material</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please add)</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

Section B YOUR USE OF ON-SITE DIGITAL TECHNOLOGIES
The following questions are about the use of digital technologies in museums or galleries. The focus is on technologies used on-site.

5 Which types of on-site digital technology do you use? When were they implemented?

<table>
<thead>
<tr>
<th>Technology</th>
<th>In the last year</th>
<th>2-3 yrs</th>
<th>4+ years ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audiovisual TV displays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audiovisual projection screens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Touchscreen kiosks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interactive projected displays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audioguides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audio and Visual portable guides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile applications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please add)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6 What proportion of your visitors use these digital technologies? This may be based on an estimate, rather than quantitative evidence.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Less than 5%</th>
<th>Up to 20%</th>
<th>Up to 50%</th>
<th>Up to 80%</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audiovisual TV displays</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Audiovisual projection screens</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Touchscreen kiosks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interactive projected displays</td>
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<td></td>
</tr>
<tr>
<td>Audioguides</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Audio and Visual portable guides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile applications</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Thinking now about what's important to your visitors:

7 Taking all your digital technologies together, how well do you think their use helps deliver value for your visitors?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Poorly</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>New experiences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fun/entertainment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tourism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meeting new people</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interacting with material</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please add)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section C YOUR ORGANISATION’S IMPLEMENTATION OF DIGITAL TECHNOLOGIES

8 How knowledgeable would you say your organisation is about digital technologies and their use in museums and galleries?

1 = Poor - only the basics                          5 = Excellent - leading the sector

9 When you implement new digital technologies, how well are members of staff identified to lead implementation and encourage visitor use?

1= Poorly - nobody specific identified          5 = Excellently - a defined group of staff lead implementation

10 How well are staff recognised and rewarded to implement new digital technology?

1 = Poorly - rarely recognised                   1 = Excellently - well recognised across organisation

Section D NEW DIGITAL TECHNOLOGIES

Moving on, the final section looks at new digital technology and its potential impact on visitor value

11 Have you heard of or used ‘Augmented Reality’?

Use it  Heard of it  No

‘Augmented Reality’ (AR) is the integration of digital information with live video or the user’s environment in real time.

AR is already used in advertising, often using a computer to overlay information or pictures on top of reality viewed through a webcam.

AR can also be used on mobile devices, to overlay information or pictures on top of what is being viewed by the device’s camera.

For example, the Museum of London ‘Streetmuseum’ app. Historic photos are overlaid on top of the real environment.

12 How would you assess the potential for augmented reality to deliver value for your visitors?

Learning
New experiences
Fun/entertainment
Community
Academic research
Tourism
Meeting new people
Interacting with material
Other (please add)

Poor  1  2  3  4  5 High potential

13 Do you think the use of Augmented Reality technology fits with your organisation’s approach to visitor services?

1 = Poor fit  5 = Excellent fit

14 If an AR tool were implemented at your organisation, what proportion of your visitors do you estimate would use AR?

Assume that the cost is similar to other digital tools and the implementation works as well as existing technologies

Less than 5%  Up to 20%  Up to 50%  Up to 80%  All

Thank you for your time

If you would like to hear about the results of this survey please leave your email address below
Please also add any comments you have about this survey

15 Email address

16 Comments

Bruce Hellman (bruce.hellman08@imperial.ac.uk, 07974 242650)  Autumn 2010
8.5. Primary research – observational study write-up, At-Bristol

Primary Research: At-Bristol, Saturday 30 October 2010

Subject of study: Augmented Reality exhibition based on aircraft landing gear

Study method: independent observation for 75 minutes

Observations:

<table>
<thead>
<tr>
<th>Time</th>
<th>Person</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.47</td>
<td>Family</td>
<td>Screen facing wrong direction. Quickly bored</td>
</tr>
<tr>
<td>12.52</td>
<td>Male 40s and female &lt;10</td>
<td>Brief view, no interaction with screen</td>
</tr>
<tr>
<td>12.54</td>
<td>Female &lt;20</td>
<td>Brief view, no interaction</td>
</tr>
<tr>
<td>12.56</td>
<td>Male 40+</td>
<td>Completed questionnaire, in-depth interaction</td>
</tr>
<tr>
<td>13.05</td>
<td>Male &lt;10</td>
<td>Looked through screen at another exhibit</td>
</tr>
<tr>
<td>13.06</td>
<td>Family</td>
<td>Looking at screen but appeared confused. Dad engages more but doesn’t use features or move screen around</td>
</tr>
<tr>
<td>13.10</td>
<td>Female 20s</td>
<td>Looking wrong way, likes seeing friends on screen. Takes photos of friends on screen</td>
</tr>
<tr>
<td>13.11</td>
<td>Father and son</td>
<td>Look at each other on the screen, but no interaction with exhibit</td>
</tr>
<tr>
<td>13.12</td>
<td>Male &lt;10</td>
<td>Looks at screen but spins to face wrong way. Presses some buttons, gets bored</td>
</tr>
<tr>
<td>13.14</td>
<td>Male 30s</td>
<td>Looks at screen, uses at arm rest while viewing other exhibit</td>
</tr>
<tr>
<td>13.15</td>
<td>Female &lt;10</td>
<td>Looks at screen pointing wrong way</td>
</tr>
<tr>
<td>13.15</td>
<td>Female 20s</td>
<td>Looking wrong way. Touches some buttons. Likes seeing friends on the screen</td>
</tr>
<tr>
<td>13.16</td>
<td>Male 20s</td>
<td>Looking wrong way. Quickly bored</td>
</tr>
<tr>
<td>13.19</td>
<td>Male &lt;10</td>
<td>Looking wrong way. Moves on quickly</td>
</tr>
<tr>
<td>13.20</td>
<td>Female 60s and female 30s</td>
<td>Looking wrong way. Seems unsure of what it’s about. Woman in 30s looks at screen but walks away without touching</td>
</tr>
<tr>
<td>13.23</td>
<td>Male 30s</td>
<td>Looking wrong way, slight interaction</td>
</tr>
<tr>
<td>13.25</td>
<td>Family</td>
<td>Enjoy seeing each other on the screen. No interaction with exhibit</td>
</tr>
</tbody>
</table>
13.28 Family Looking wrong way

13.32 Male <10 Looking wrong way, little interaction, presses some buttons

13.34 Females 20s Look at screen but move on without touching

13.34 Female 20s Touches buttons, enjoys looking at friends through the screen. Waving through the camera, looking the wrong way

13.36 2 males, 1 female, 20s Looking wrong way. Touching buttons and viewing information. Male looks up a few parts of the gear. Gets quickly bored as rest of group move on

13.40 Male 20s Looks at screen facing correct way. Touches buttons and watches some content. Disturbed by children in group. Attempts to show children the exhibit, but not interested for long

13.46 Female 30s Looks at screen in correct direction. Moves around and looks at content. Touches buttons but quickly moves on

13.47 Female <10 Uses to spin around quickly, no interaction with exhibit

13.49 Mum and girl Looks at landing gear, then uses for spinning around. Look at each other on screen

13.52 Female <10 Looking wrong way, quickly bored

13.55 Male teenage Looks at screen, touches buttons and moves screen to look at exhibit. Links screen to exhibit, but quickly bored

13.56 Male <10 Looking wrong way. Likes to view others on the screen, especially the Dad

13.58 Female <10 Uses to view camera and other exhibits on screen. Uses for spinning around

13.59 Male 50s Views screen, touches buttons but quickly loses interest

Summary

- Most visitors did not use the screen in its intended way
- Most popular use was as a screen to view other people on; followed by something to spin around
- **Exhibit in present form does not fit with the other exhibits as is not as immediately interactive and not clear what people should do with it**
- Often facing in wrong direction so people do not link screen with the landing gear
The height is difficult for younger children to use

Exhibit was alongside other very popular exhibits (hot air balloon, wind blower and foam aeroplanes); in such a competitive context it lost out to more immediately obvious and interactive exhibits

No added value in the AR nature of the exhibit – this actually detracted as it meant people used it as a camera to see other people. A flat screen would be more effective to view and launch content

AR offered no added value when compared with a flat exhibit

Conclusions
Exhibits must fit with the visitors’ expected way of interpreting the exhibits. In the case of At-Bristol all other exhibits were very hands-on and immediately obvious how to interact with them. The AR exhibit failed as it was significantly less hands-on than other exhibits and was not immediately obvious what visitors should do with it.

Furthermore the technology did not work effectively because:

- The screen was filled with too much content;
- The AR did not track the camera image with a high enough refresh rate; and
- The AR did not highlight what section of exhibit was being viewed.

The application was a crude version of visual search – it did not overlay more information on top of what was seen and did not present the visitor with a new experience that was not possible through a flat screen and selections from a menu. The screen mostly pointed in the wrong direction, so was unclear that it was for the landing gear exhibit

Positive points
Visitors enjoyed viewing others through the camera – this should be incorporated into future exhibits (which is planned).
8.6. Andover Museum of the Iron Age questionnaire write-up

Primary research – on-site survey: Andover’s Museum of the Iron Age, Saturday 16 October 2010

Questionnaire data and user feedback was taken at the Museum of the Iron Age in Andover on use of the Viz*it augmented reality experience. Visitors were provided with a Nokia N95 phone, which used 4 QR markers to launch audiovisual content during the visit. Markers 1, 3 and 4 were used to launch video content; marker 2 launched a 3D animated warrior which could only be seen while the marker was in the camera’s view.

<table>
<thead>
<tr>
<th>Question (all marked 1 = Low to 5 = High)</th>
<th>Median</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall enjoyment of the museum</td>
<td>4</td>
<td>4.3</td>
</tr>
<tr>
<td>Enjoyment of Viz*it</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>How much did Viz*it help improve understanding of the Iron Age?</td>
<td>4</td>
<td>3.3</td>
</tr>
<tr>
<td>Would this experience encourage you to return to museum?</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>Should such experiences be implemented at other museums?</td>
<td>4</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Figure X – Survey data from primary research at the Museum of the Iron Age

Survey size was 14 during a 3 hour period: 5 under 15 years old; 2 between 15 – 35; and 7 over 35. The survey size comprised around 80% of total visitors during the study period. Given a small sample size, these results are assumed to provide anecdotal supporting views rather than robust quantitative evidence.

It should be noted that no participants had prior experience of AR. The key observation was that participants enjoyed the experience, despite feeling that the technical delivery was poor.

Key comments from users were captured on questionnaires and in discussion:

- Difficult to know what to do and how the technology works
- Wasn't clear when the marker launched a video, and when you had to hold it in front of the marker
• Better when marker didn't have to remain in view
• **Technology was difficult to understand**
• Poor navigation on the screen between markers
• Not all phones launched the same content - first marker didn't work for some phones
• Lost interest when warrior kept cutting out, as phone was moved away from marker
• Would prefer to see content on large screen
• **Would consider paying for an app (up to £5) if it could be used across a number of museums**
• Markers need to be obvious so they are not missed
• Better for younger generation, not those over 50
8.7. Andover Iron Age museum questionnaire

Imperial College Business School
MBA project

The use of digital technologies at visitor organisations

Please circle chosen responses.

**Male / Female**

<table>
<thead>
<tr>
<th>Under 15</th>
<th>15 – 25</th>
<th>26 – 35</th>
<th>35 – 59</th>
<th>60+</th>
</tr>
</thead>
</table>

How often do you visit the museum?

<table>
<thead>
<tr>
<th>1st time</th>
<th>Less than once a year</th>
<th>2 – 3 times per year</th>
<th>4 – 6 times per year</th>
<th>7+ times per year</th>
</tr>
</thead>
</table>

General enjoyment of the museum:

<table>
<thead>
<tr>
<th>1 = Poor, failed to meet expectations</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 = Excellent, surpassed expectations</th>
</tr>
</thead>
</table>

Reason for visit:

- Learning
- New experiences
- Fun/entertainment
- Friendly community of people
- Academic research
- Tourism
- Meeting new people
- Interacting with material
- To try out augmented reality!
**Did you enjoy using the Viz*it augmented reality experience?**

<table>
<thead>
<tr>
<th>1 = Not enjoyable</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 = Excellent, very enjoyable</th>
</tr>
</thead>
</table>

**Thinking about the Viz*it experience, was the content:**

- Too short
- About right
- Too long

**How much did the Viz*it experience help you better understand the Iron Age?**

<table>
<thead>
<tr>
<th>1 = Not much</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 = A great deal</th>
</tr>
</thead>
</table>

**Would this experience encourage you to come back to the museum?**

<table>
<thead>
<tr>
<th>1 = Wouldn’t affect decision</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 = Would make me come back</th>
</tr>
</thead>
</table>

**Do you think museums and art galleries should use experiences like this more often?**

<table>
<thead>
<tr>
<th>1 = No</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 = Definitely</th>
</tr>
</thead>
</table>

What if you had to pay for the experience? Please use an ‘X’ to show how this would affect your score above.

**Do you have any comments about the Viz*it experience?**

Thank you for your participation in this questionnaire.
8.8. Klein’s matrix for organisational readiness to adopt innovations

<table>
<thead>
<tr>
<th>Strong Implementation climate</th>
<th>Innovation-Values Fit</th>
<th>Weak Implementation climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee opposition and resistance</td>
<td>Poor</td>
<td>Employee relief</td>
</tr>
<tr>
<td>Compliant innovation use, at best</td>
<td>Neutral</td>
<td>Essentially no innovation use</td>
</tr>
<tr>
<td>Adequate innovation use</td>
<td>Good</td>
<td>Employee disregard</td>
</tr>
<tr>
<td>Committed, consistent and creative innovation use</td>
<td></td>
<td>Essentially no innovation use</td>
</tr>
<tr>
<td>Sporadic and inadequate innovation use</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 50: Klein (1996) matrix for organisational readiness for innovation*

Survey results from this study’s primary research questionnaire were plotted on the Klein matrix using the following questions:

**Vertical axis,** an average of two questions, each marked on a 1 – 5 scale:
- When you implement new digital technologies, how well are members of staff identified to lead implementation and encourage visitor use?
- How well are staff recognised and rewarded to implement new digital technology?

**Horizontal axis:**
- Do you think the use of Augmented Reality technology fits with your organisation's approach to visitor services?
8.9. Further evidence on visitor value and AR vs existing digital technologies, relevant to section 5.2.2

Figure 51 sets out research from Fusion + Analytics on the key reasons visitors took an iPod Touch museum guide. This evidence supports this study’s primary research on what visitors value; and highlights the areas museums and galleries should consider when designing new AR (as well as other mobile) applications.

![Figure 51 – Reasons visitors took an iPod museum tour. Source: Petrie, 2010.](image)

Additional evidence from this study’s online questionnaire supports the findings that organisations believe that AR will deliver greater value than other digital technologies. The online questionnaire collected evidence around the sector’s use of AR and other digital technologies.

Figure 52 presents data on the proportion of organisations’ visitors who use various types of digital technology. Organisations were asked to rate the proportion of their visitors that used a variety of digital technologies. Choices available were: less than 5%; up to 20%; up to 50%; up to 80%; or All. These bands roughly translate to the innovation adoption categories (Moore, 2006 and Rogers, 2009).
The data indicate that on average a relative minority of visitors make use of digital technologies in museums. The results show that organisations believe that augmented reality could be taken up by more people than currently use audio or multimedia guides. This may be related to the visitor value organisations perceive AR can offer.

The average (median) response is shown by a triangle. The blue line indicates the spread of responses.

*Figure 52 – Primary research: organisations’ estimates of uptake of digital technologies. Source of bell curve: Passion for Process.*