RICHES

RENEWAL, INNOVATION AND CHANGE:
HERITAGE AND EUROPEAN SOCIETY

This project has received funding from the European Union's Seventh Framework programme for research, technological development and demonstration under grant agreement no. 612789

D5.4 CH Best Practice in the Digital Economy

Partner responsible for deliverable: UNIEXE

Deliverable authors:

Catherine Cummings, Charlotte Waelde (UNIEXE)

- Subject to final approval -

Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

RICHES deliverable D5.4: *Cultural Heritage Best Practice in the Digital Economy* addresses one the most important issues for the future of cultural heritage: experimentation and innovation in digital technology in a time of social and technological change.

The digital economy has transformed all sectors of society and the cultural heritage (CH) institution, as a social institution has undergone a 'digital renaissance'. The ways in which we engage with, understand, communicate, participate and disseminate CH has been transformed through the use of digital technology (DT). The CH institution has shifted practice from being object centred and a custodian of CH to a social institution where visitors can be interactive, participative and co-creative and where they can access CH in new, creative and novel ways through the use of DT. Experimental and innovative DT is rapid and continuous and the CH visitor has become digitally literate and increasingly constantly connected. In order to remain relevant for existing audiences, to attract a new generation of visitors and to continue to contribute to Europe's creative economy, it is vital that the CH sector invests in new and emerging technologies.

There is a great deal of experimentation and ideas within CH and DT that takes place within academic research institutions. This deliverable addresses this body of knowledge and how, by working in partnership with the CH sector, it can contribute to the transformation of how European CH is accessed, communicated, interpreted and disseminated. It acknowledges that the CH sector is important to Europe's creative economy and that experimentation and innovation in DT is contingent on funding. The deliverable gives an overview of European strategies and funding bodies that promote and support collaborative projects that are experimental in developing innovative DT for the CH sector and which are engaging and enhance the CH visitor experience.

Through a series of examples of best practice in collaborations between the CH sector and the academic research institution this deliverable identifies what has been done in publicly-funded projects that aim to transform "cultural artefacts and our understanding, and experience of CH, using new technologies" and which "narrow the gap between the experimental in the research institution and its practical implementation in the digital economy" (RICHES DoW, Part A: 18). This deliverable suggests that CH has cultural value as well as economic value. It emphasises the importance of experimentation and innovation in DT in the European CH sector to attract a new generation of CH visitors and increase the potential to contribute to Europe's economic growth and to avoid a digital dark age.

The outcomes can be used by CH sector when considering collaboration with academic research institutions in the development of DT and to show how DT can engage and enhance the visitor experience in how CH is accessed, communicated, interpreted and disseminated CH.

2. INTRODUCTION

This deliverable is part of RICHES *WP5 Impact of CH on EU economic development* which addresses the impact of CH on EU economic development. RICHES D5.4 *Cultural Heritage Best Practice in the Digital Economy* addresses one the most important issues for the future of cultural heritage: that of experimentation and innovation in digital technology in a time of social and technological change.

Contextualised within the RICHES project, this deliverable aims to identify some of the best practice in innovative DT and how it is translated into the CH sector. It is based on RICHES Task 5.4: *Innovation and Experimentation in the Digital Economy* and aims to investigate and evaluate the "transformative potential for cultural artefacts and processes offered by digital technologies" (RICHES DoW Part A: 19). It addresses how DT can generate new knowledge and understanding of European CH and the potential of it to transform CH practice, to bring about change and to recalibrate relationships in the CH sector and its public.

DT is ubiquitous and has pervaded all aspects of contemporary social life and CH institutions, as social institutions, have faced enormous challenges in adopting new working practices based on new and emergent technologies in a 'digital renaissance'. The deliverable addresses how the CH sector has embraced and implemented new DT, which has changed and shifted CH practice to develop a more democratic approach to CH and to practices that are interactive, participatory and co-created.[1] The ways in which we engage with, understand, communicate, participate and disseminate CH has been transformed through the use of DT. As new technologies continue to evolve and emerge at a rapid pace, some CH visitors have also evolved to become digitally literate and to expect a digital, interactive experience as in other aspects of their life. Today CH institutions have to cater for an audience which increasingly is accustomed to being an (inter)active part of any cultural experience (Message 2006).

Contextualised within the 'New Museology' and goals to make collections more accessible and to engage and enhance visitor experience DTs have become an intrinsic part of CH. The digitisation of CH and future technology and the increasing use of personal mobile devices, wearable technologies and Cloud computing will enable the CH visitor to be constantly connected, anytime and anywhere. The deliverable acknowledges that DT itself is constantly changing and evolving with ongoing and continuous new and emerging innovations that have had an enormous transformative effect on European society. CH institutions, as social institutions, are challenged with keeping pace with these new technologies.

[1] The term 'democratic' in this deliverable is used in the context of changing practices which are part of the democratisation process of museums through practices such as co-creation and participation and to address issues of widening access and inclusion. The degrees to which these are effective, moral or ethical are beyond the scope of this deliverable. The democratic process in CH institutions is questionable and remains a dilemma: is it for widening access, enhancing visitor participation and engagement or for purely economic reasons to increase visitor numbers?

The deliverable suggests that in a rapidly changing and technological world institutions cannot afford to stand still and in order to keep pace with this they will need to continually embrace new innovations and be open to new practices based on DT in order to be a CH institution of the future.[2] Experimentation and innovation in DT can be costly and time-consuming, so how can the CH adapt and keep pace with these changes?

Many experimental and innovative technologies are developed within research institutions throughout Europe and this "knowledge is a fertile source of ideas, methodologies and products that could contribute to the transformation of our CH sector and our communication with, and engagement and participation in it" (RICHES DoW, Part A: 18). Working in partnership with such institutions, the CH sector can have access and share ideas, concepts, knowledge and funding. Many universities have worked with external business and the creative sector. This demonstrates the proactive approach of research academies in being open to collaboration in interdisciplinary projects in order to enable their research to have an impact on society. The university sector intervention into CH and working collaboratively can have benefits and value for all in the sharing of ideas and knowledge and a recalibration of relationships between CH practitioners and academic researchers. This deliverable is contextualised within this shifting and changing environment as it seeks to "analyse innovation and experimentation in the digital economy" (RICHES DoW, Part A: 16).

One of the aims of this deliverable is to focus on best practice and collaborative projects between CH institution and the academic research institution in the creation of experimental and innovative technologies which can be implemented in the CH institution and which have the potential to transform the way in which CH is accessed, communicated, interpreted and participated in. Research questions include:

- What are the new and emerging digital technologies?
- What is the best practice in digital technology in the CH sector?
- How is experimentation and innovation in CH funded?
- What are the benefits and challenges of investing in experimentation and innovation in digital technology in the cultural heritage sector?
- What are the benefits and challenges of collaboration between a CH institution and an academic research institution?

The purpose of this deliverable is to offer an insight into CH best practice in the digital economy through collaborative interdisciplinary projects that engage CH institutions with academic research institutions.

[2] This comes with the caveat that there are many different types of CH institution and that the development and implementation of DT has to be relevant and reflect their individual strategy and purpose.

Through a series of examples of best practice in collaborations between the CH sector and the academic research institution this deliverable identifies what has been done in publicly-funded projects that aim to transform "cultural artefacts and our understanding, and experience of CH, using new technologies" and which "narrow the gap between the experimental in the research institution and its practical implementation in the digital economy" (RICHES DoW, Part A: 18).

The adoption of digital media by cultural institutions has a crucial role in their practice. One of the ways in which this has been achieved is in the use of new and emerging technologies. This deliverable addresses some of the best practice in the CH sector but it takes this further in examining some of the ways in which CH institutions actively seek out and engage with new research to cater for the expectations of a digitally educated audience.

Experimentation and innovation in DT is contingent on funding. The deliverable addresses European governments' policies, digital agendas and public-funded bodies which support and fund innovative CH projects. It offers examples of best practice to those seeking to engage in partnerships with similar projects and new and emerging technologies. The projects and two case-studies were chosen due to their inter-disciplinary research which develop experimental and innovative DT for application in the CH sector and which have the potential to contribute to Europe's economy and raise interesting issues and challenges relevant to the topic. In addition to discussing practical innovation and emerging technologies, this deliverable is concerned with the impact and value of new and emerging technologies and the potential change this brings about in the CH sector.

The deliverable situates the CH institution as a cultural and social institution but it also has an economic role. CH institutions are part of the creative industries and they contribute to and have an impact on EU economic development. In being responsive to the potential of DT, by engaging with it and implementing it, the deliverable suggests that CH institutions can address a wider audience, attract new audiences and remain relevant for a contemporary audience and continue to have an impact on EU economic development.

It suggests that collaborating and working in a multi-disciplinary partnership in developing experimental and innovative technologies can result in new knowledges, new working practices and can generate value for all of those involved.

The objectives of the deliverable are to:

- Identify a range of best practice projects in experimental and innovative DT and how they are implemented in the CH sector
- Understand importance of supporting and funding innovation and experimentation in digital technology to create impact and value in the European economy

- Analyse how innovation and experimentation in the digital technology can impact on how we access, interpret, participate in and preserve CH
- Assess the impact of innovation and experimentation on CH institutions and its audience(s)
- Examine the relationship between CH institutions and the academic research institution and understand the benefits to CH from collaborative partnerships.

The deliverable highlights the importance for the CH sector to continue to experiment and innovate in DT in order to remain relevant for an existing contemporary audience and in attracting a new digitally literate generation of visitors. This will help to increase revenue, enable it to continue to contribute to Europe's economic growth.

2.1 Background

The RICHES project is concerned with change. The deliverable situates the CH institution as a social institution at the intersection of society, politics, economics and culture. Changes and trends have an impact on the CH sector and how CH is accessed, communicated, preserved and disseminated. Changes include:

- Trends in Society: How society has changed and the impact of this on the CH sector
- Trends in Politics: Governments' initiatives, policies and strategies which highlight the importance of CH and which support and fund the CH sector
- Trends in Digital Technology: Future and emerging technologies (mobile device, Cloud computing, ubiquitous computing), new systems of communication and the impact of this on the CH sector. Governments' initiatives and public-funding to support the digitisation of CH.
- Trends in Economics: How can the CH sector contribute to Europe's economic growth?
- Trends in Cultural Heritage: What do these changes mean for Europe's CH? New CH practices: co-creation, participation and the democratisation of CH.

All of these trends overlap and have an impact on the CH sector. Some of the main contexts in which to discuss these trends is through the impact DT has had on society, politics, economics and culture. One of the aims of this deliverable is to examine the possibilities and transformative potential of DT in how CH can be accessed, communicated, interpreted and disseminated through a range of collaborative projects in experimentation and innovation in DT. The background to this deliverable is based on best practice in the CH institution and the academic research institution in collaborative working to develop experimental and innovate ways to enhance the visitor experience of CH.

The use of novel and innovative DT in the CH sector can have many benefits for the CH institution and their audience and this in turn can increase financial gain. Within this deliverable the CH sector is contextualised within the rapid changes and developments of experimental and innovative DT and highlights the importance of the need to engage with innovation and experimentation in the digital economy and how this can contribute to Europe's economic growth.

The European CH Institution

Discourse on the history of the European museum positions it as a dominant cultural institution as an instrument of power and control (Bennett 1995; Macdonald 1998; Smith 2006; Wilson 2010). DT is continually reshaping the way in which we perceive and engage with the world around us and how we access, communicate, interpret, preserve and participate in CH. The emergence and increasing use of Web 2.0 technologies and the implementation of digitisation in the CH sector has resulted in a radical change and shift in how CH is communicated, accessed, interpreted and disseminated.

In the last three decades the CH institution has faced many challenges and changes including shifts in practice from their custodial role in being concerned with collections and conservation to becoming a social and commercial institution –and part of what has been termed the 'creative industries'. This shift toward commercialisation of cultural heritage implies that the CH institution can be understood as a creative business that contributes to society and economic growth. In order to achieve this CH practice includes entrepreneurship and collaboration with external agencies to develop innovative approaches to engaging their visitors and making their collections accessible and open. In his book 'The New Museology' (1989) Peter Vergo asked the question "What is museology?" (Vergo 1989: 1) which he defined as "a state of widespread dissatisfaction with the 'old' museology both within and outside the museum profession" (Vergo 1989: 3). In addressing the change in museums in the 1980s, he declared that the "Museum is said to be undergoing a 'renaissance'… "it has become a place for visiting exhibitions, eating, studying, conserving and restoring artefacts, listening to music, seeing films, holding discussions, and meeting people" (Lumley 1988:1).

In the twenty-first century with the advent of the internet and the rapid increase in digital technologies, society can be said to have undergone a 'digital renaissance' with a new generation of digitally educated curators and CH visitors with new expectations in accessing, communicating and disseminating cultural heritage. The CH institution is a social institution and "if social change encourages changes in museum practice, it can also bring about a shift in the social role of the museums and other cultural institutions" (Lumley 1988: 167).

CH collections are now both physical and digital, audiences more diverse: they are virtual and real, and they are global. The adoption of DT can help CH institutions to reach audiences who are too remote or unable to access the physical space of the museum – through the use of DT they can access collections, data about objects and in some cases can contribute to the interpretation of objects, artefacts and archives. This connecting and networking can create value and increase and maintain visitors. For example, Katie Price, head of Digital Media at the Victoria and Albert Museum in London states, "The V&A website attracts four times as many visitors as the museum – which in 2014 welcomed over 3 million people – and they come from all over the world, as well as from all kinds of sources" (Aitch 2015).[3]

As CH institutions continue to change the expectations of the public and the CH visitor have also changed due to digitisation who now expect to have access to a wide array of information instantly. According to Visser (2014) CH institutions have become 'social institutions' with practices that include interaction and co-creating and relationships between the CH and their visitors have been recalibrated to share the power to interpret with their visitors.[4]

Museums are in the business of communicating culture but this communication is no longer in the sole control of the CH institution – rather it has become a two-way system – the 'prosumer' and 'producer'. As new innovative developments in DT are constantly emerging and becoming ever more ubiquitous, European society has access to a wide variety of information through different types of DT. Today CH institutions are competing for "the attention of the people" (Runnell and Pruulmann-Vengerfeldt 2014: 14).

> *Digital technologies have brought disruption and uncertainty as well as opportunities in all aspects of social, economic and cultural life and continue to develop rapidly and radically. Big Data, the Internet of Things, Wearable Computers, Assisted Creativity and the Maker Movement provide examples of this continued dynamic.*[5]

For CH institutions to remain relevant and maintain their existing audience and to attract a new generation of visitors, the deliverable advocates the importance of the CH sector in experimenting and innovating in new and emerging Web.3.0 technology.

[3] Iain Aitch (2015) 'The Global Museum' available at: http://artsdigitalrnd.org.uk/features/the-global-museum/
[4] Keynote speech by J. Visser at the Canadian Museums Association Conference 2014. http://themuseumofthefuture.com/2014/04/18/museums-in-times-of-social-and-technological-change/ [accessed: 18/06/2015].
[5] Hasan Bakhshi, Ian Hargreaves and Juan Mateos-Garcia (2013) Nesta's *Manifesto for the Creative Economy.* http://www.nesta.org.uk/publications/manifesto-creative-economy.

However, keeping pace with new and emerging technologies in society can be time-consuming and expensive and the deliverable suggests that one way to overcome this is to work in collaboration with external agencies such as the academic research institution.

The Academic Institution

In recent years there has been a culture change in the academic research institution in terms of the social impact of their research. Innovation and experimentation in DT is often carried out in research institutions and the results have not always been transmitted or applied to society. However, this insular culture of isolated research is changing. University research departments are no longer isolated from the wider community and society rather there has been strategic move to integrate research projects and outcomes with the public. Many universities have a dedicated research department to help to embed digital technologies in collaborative activities and interdisciplinary research projects. Knowledge Transfer departments work to connect this research in the university to that of the wider world. New courses have developed in Digital Humanities and this will result in a new workforce of skilled CH professionals trained in DT: this emergent world will have an impact of the future of the CH sector.[6] Much academic research is reliant on external funding and some funding bodies such as the Arts and Humanities Research Council (AHRC) and the Economic and Social Research Council (ESRC) in the UK fund research projects that involve collaborative multi-disciplinary teams and which have an economic and social impact beyond the academy.

Digitisation in CH has required CH professionals to re-think methods of working in multi-disciplinary ways for example with academic researchers and computer scientists. This has allowed for the sharing of expertise and ideas, the creation of new ones and the creation of new knowledge(s). This deliverable is specifically concerned with collaborative projects in the design and development of new DT and the collaboration between CH institution and the academic research institution. It suggests that collaborative working and developing partnerships is instrumental for the CH sector and its contribution to the creative economy and that the academic research institution has an important part to play in supporting this.

[6] There are numerous courses on Digital Humanities throughout the world. According to Lisa Spiro, "Digital Humanities is not technology for the sake of technology. It can encompass a wide range of work, such as building digital collections, constructing geo-temporal visualisations, analysing large collections of data, creating 3D models, re-imagining scholarly communication, facilitating participatory scholarship, developing theoretical approaches to the artefacts of digital culture, practicing innovative digital pedagogy, and more". Spiro in Digital Scholarship in the Humanities: https://digitalscholarship.wordpress.com/2011/10/14/getting-started-in-the-digital-humanities/

The Economics of Culture

In addition to its cultural and social role the CH institution it is also an important part of the creative economy,

> *The third role comes from the museum as an institution operating within the economic field, where museums need to compete in the open market for clients' leisure and free time. Here museums need to collect revenues and attract visitors. At the same time museums today are increasingly seen as vital parts of the creative economy and their roles are being acknowledged as actively negotiated and fluid* (Runnel and Pruulmann-Vengerfeldt 2012: 328).

This deliverable situates the CH sector as a creative industry and links experimentation and innovation in DT in the CH sector with economic growth evidenced by the interest of European government strategies that support and fund DT in the CH sector. For example, NESTA in the UK assert, "the digital revolution is now very much underway, and almost certainly accelerating. This has obvious implications for the UK given the remarkable scale of the creative economy" (Geoff Mulgan, Chief Executive of Nesta. Foreword in Bakshi et al. 2013).

There are numerous European initiative and policies which support and fund DT projects in the CH sector, which demonstrates the interest and commitment in DT and the social and economic value of CH,

> *In Europe there is a growing recognition for the value and importance of cultural heritage as both a social and economic resource. It contributes to forming an individual and collective identity, supports social and territorial cohesion, is of great economic importance for the tourism industry, and has potential for defining new types of artistic careers. This importance for society and economy demands a better protection, promotion and use of our cultural heritage* (Koers, W. et al. 2012.

The changes in society and the changes in the CH visitor have created changes in the CH sector. In order to maintain their existing visitors and to attract a new generation of digitally literate visitors, the CH institution has had to adapt to cater for them. This can have benefits such as increasing revenue,

> *In the economic field, the ultimate key seems to be in understanding the customer and proposing mutually beneficial partnerships in order to maintain economic dominance and gain profits* (Runnel and Pruulmann-Vengerfeldt 2012: 331)

New technologies continue to develop and evolve from Web 2.0 technologies to the next generation of Web 3.0 or the Semantic Web, which includes intelligent computing. Pervasive and adaptive technologies can adapt content according to the visitor interests through the use of sensors. Emergent technologies are also 'immersive' in that they blur the line between the real physical world and the virtual world, creating an experience of being 'immersed', for example, augmented reality.

The Internet of Things (IoT) includes 'smart technology' in which smart applications can wirelessly communicate between themselves, objects and buildings – machine to machine (M2M) technology.[7] The increasing development of mobile technologies, wearable technologies and mobile internet allow visitors to be connected anytime and anywhere,

> *The global wearable technology market as a whole is expected to grow at a compound annual rate of 35% over the next five years primarily dominated by Apple and Google, who already comprise 90% of the mobile platform market. While North America and Europe are the largest players in the global market, Asia is expected to show increased growth rates over the next several years* (Johnson, L. et al. 2015: 242).

This demonstrates that experimentation and innovation in DT is continuously evolving and DTs, as communicative technologies, allow for and enable the changes in CH institutions by enabling participation, dialogue and democratisation,

> *At the same time, the way of thinking about cultural heritage is evolving and the way cultural heritage is developed, appropriated, enriched, promoted and transmitted is also changing. Sources of cultural heritage are increasingly preserved and transmitted digitally and online, offering new ways of sharing, analysing and presenting cultural heritage* (Koers et al.2012).

These developments and changes highlight the importance of keeping pace with innovation and experimentation in digital technology and they will continue to transform how we "understand our CH, how we engage with it and alter it, how we communicate and participate in it" (RICHES DoW Part A: 18).

[7] Smart technology is "a cognitive, contextually aware computing system capable of making decisions without human intervention. Smart machines use machine learning and data catchments to perform work traditionally conducted by human" (http://www.theguardian.com/sustainable-business/2015/apr/17/things-need-know-sustainable-smart-technology). Smart technology can track your movement, monitor your heartbeat and can learn your behaviour and adjust accordingly.

2.2 Role of this Deliverable in the Project

The purpose of this deliverable is to offer an insight into some of the best practice in collaborative projects between the CH sector and the academic research institution in the experimentation and innovation of DT. The deliverable is linked with WP5 *Impact of CH on EU economic development* and complements Task 5.3 *Fiscal Issues in the Digital Age and CH,* which addresses DT and "how access to those technologies influences CH nowadays and in the future" (RICHES DoW Part A: 17). It includes the digitisation of heritage collections as an indicator of innovation and argues that there are enormous opportunities for the growth and sustainability of CH institutions but innovation and foresight planning is essential for this to happen.

> *Digital technologies are disrupting established practices and creating new opportunities for innovation across the creative economy. Some arts and cultural organisations are experiencing transformational impacts, using digital technology to reach bigger audiences than ever before.*[8]

Digital technology is ubiquitous and pervasive and as it continues to evolve visitors' expectations also evolves and changes. In an era of financial crisis and funding cuts, innovation and experimentation in digital technology for the cultural heritage sector is of paramount importance for keeping pace with these changes, to compete with other industries and to maintain the potential for economic growth. This deliverable argues that innovation and experimentation in digital technology can be a source of economic value as well as cultural value.

This deliverable considers the impetus for innovation through European government strategies and policies that support and encourage experimentation in DT and emphasises the importance of innovation and experimentation in developing new approaches to how we access, communicate, interpret, preserve and disseminate Europe's CH. it reflects on the impact of DT on CH through a range of best practice projects contextualised at the intersections of social, political, cultural and economic and addresses "how can economic growth be attained through balanced pursuit of innovation while exploiting the immense value of our cultural heritage" (RICHES D5.1: 12).

DT is "profoundly influencing and shaping the environment of change in our society". This deliverable demonstrates the benefits and impacts of this on how they can "open the way to new, distributed, ways of working, communicating and investigating new products and services in the CH sector, as in other sectors" (RICHES DOW: Part A: 4). It also, however, acknowledges that it is not without its challenges and limitations.

[8] Hasan Bakhshi Director, Creative Economy, Nesta Policy & Research Unit, *Digital R&D Fund for the Arts: Digital Culture: How arts and cultural organisations in England use technology.* Final Report available at: http://artsdigitalrnd.org.uk/wpcontent/uploads/2013/11/DigitalCulture_FullReport.pdf.

Many DTs are interactive and participatory and engage the visitor in new ways which demonstrates the willingness of the CH sector to experiment with innovative DT, to increase their public engagement and to provide high quality experiences for their visitors. This is important in increasing visitor numbers and to attract a new generation of visitors which in turn can increase revenue and contribute to the creative economy. DT is continuously changing and evolving and the audience for this technology is also evolving and expecting an innovative high quality experience. This deliverable emphasises the importance for the CH sector in experimenting in innovative DT to keep pace with these changes in maintaining existing visitors and attracting a new generation of visitors. At a time of public funding cuts this has the potential for higher visitor numbers and income generation.

The deliverable complements RICHES D3.1: *Transformation, Change and Best Practice for CH processes* which addresses the "changes taking place in the management and transmission of CH, largely as a consequence of the advent of the digital" (RICHES DOW Part A: 9). In developing innovative DT, CH professionals have worked in partnership and collaborated with a range of external agencies, including, but not limited to, academic researchers in Higher Education institutions, scientists and technologists. Working in partnerships and collaboration in multi-disciplinary teams, sharing knowledge and developing new ways of working can be transformative and can recalibrate relationships not only with and between CH professionals but also with external agencies. This deliverable highlights the importance of multi-disciplinary teamwork in engaging with innovative and experimental technologies. Developing new innovative DT may require new skills and can have an impact on the workforce who will require training in the use of them. Digital literacy needs to be a requirement across the institution. However these new skill do not simply replace existing ones but enhance and complement them bring richer and expanded set of skills to produce a highly skilled workforce. Working in partnership with academic research institution can have positive benefits for all parties but most importantly for the CH visitor in enhancing their engagement with, and experience of, CH.

2.3 Scope of Deliverable

"There is not one digital strategy … there are thousands".[9]

Research into experimental and innovative future technologies is vast as is the literature relating to DT and CH. For the purpose of this deliverable it was decided to focus on the CH institution, namely the museum and the collaborative partnerships with research institutions. There is so much adoption of DT in the CH sector that not all could be addressed in this deliverable.

[9] Martin Roth, Director, Victoria and Albert Museum, London in *V & A: The Global Museum* available at: http://artsdigitalrnd.org.uk/features/the-global-museum/ [accessed 03/09/2015].

For example the use of social media for marketing and promotion of exhibitions, although important, has not been covered in any depth as this was beyond the scope of the deliverable. Examples of experimental and innovative projects and two case studies were chosen due to their interdisciplinary and collaborative partnerships between CH institutions, academic research institutions and creative technologists. They are all examples of how experimentation and innovation in DT can enhance and engage the CH visitor through interactivity and participation and the new ways in which CH can be accessed, communicated, interpreted and disseminated.

Experimentation and innovation is contingent on funding, and the deliverable includes an overview of the European strategies and funding bodies that support and fund DT projects in the CH sector. This was to give an insight into the importance of digitisation for the future growth and sustainability of the CH sector by the European Commission and public-funding bodies.

What is beyond the scope of the study?

The deliverable discusses the changing practice in the CH institution as part of the democratisation process in museums. However, the extent to which this has been achieved, if at all, is not addressed in the deliverable. The implications and effects of DT on the CH visitor and the complex ethical considerations in the use of DT, by the CH institution and by the user, although important, would require further research and a specific set of research questions. The CH sector may require a changing role for the CH professional and they may require training in specific skills but this was outside the parameters of the deliverable.

The examples of projects discussed and the two case studies are part of an ongoing continuum of change and recalibration due to digitisation. Some of the example projects and case studies have emerged and evolved out of other experiments and some have led to new collaborations and projects that are not addressed in the deliverable. Collaborative working and the changes brought about by digitisation may also result in a recalibration of relationships, professional identities, expertise and skills, and although this is acknowledged and is intrinsic to the deliverable, it is not discussed in any depth as this would require a different research theme.

Experimental and innovative DT has implications in terms of copyright law and raises questions around ownership and authorship. Working in partnership and collaboration in the development of ideas and concepts and new technologies is also legally problematic, but it was beyond the scope of the deliverable to address these issues. It is, however, the focus of RICHES deliverable D2.2 *Digital Copyrights Framework*.

2.4 Methodology

The research methodology was diverse and included:

- Desk Research
- Literature Review
- Semi-structured email interviews with expert staff – museums and universities
- Case study 1: collaborative project between CH institution and academic research institution
- Case study 2: collaborative project between CH institution and academic research institution
- Questionnaire

A Literature review was undertaken on the 'new museology' to gain an understanding of the changes and shifts in museum practice during the last two decades. This was to gain an understanding of how CH institutions relate to, and communicate with, their audience and the changes and shifts in CH practice. This literature reflects the changing nature and shifting practice in museums, in particular the idea of the 'participatory museum' (Simon 2010) brought about by the implementation of a variety of DT that reflect changes in European society.

Extensive research was undertaken to gain an insight and understanding of the development and use of DT in the CH sector to answer the question "What current developments in DT are being implemented in the CH sector". This enabled the identification of the many various ways in which DT has been used in the CH sector in the last twenty years and how this is continuously and rapidly being developed. Research included:

- Online websites that address DT and CH
- Academic articles on DT
- Academic articles on museum and CH practice
- European Commission programmes and funding strategies
- Public-funding bodies

New and emerging technologies and their potential to be used in the CH sector were identified and how these have been implemented in the CH institution. This revealed some of the changes in CH practice brought about by digitisation. The importance of the CH sector to experiment and innovate in DT to remain relevant for a contemporary society was highlighted and is emphasised throughout this deliverable.

Extensive desk research was undertaken into European governments' initiatives, policies and strategies which encourage and support experimentation and innovation in DT for the development of the CH sector and growth of Europe's economy.

This was concerned particularly with those agencies interested in collaborative working and developing partnerships between CH institutions and practitioners, academic researchers and technologists to produce new knowledge, new understandings and new CH practices relevant for a contemporary, digital audience.

The Projects and Case studies

The aim of this deliverable is to give an insight into best practice in experimentation and innovation in DT in the CH sector. CH institutions and organisations such as DARIAH were contacted by email for information on potential collaborative projects between CH institutions and academic research institutions that involved experimentation and innovation in DT and CH. There are numerous projects throughout Europe that fit this criterion but it would not be possible to include all of them. For the purpose of keeping the deliverable manageable the projects chosen include those that were:

- Publicly-funded
- Collaboration between the CH institution and the academic research institution
- Use mobile technologies
- Emphasis on interactive DT
- Encourage a 'participatory' culture
- Employ Web 3.0 next generation 'smart' technology

A questionnaire was designed for participants in the case studies. It was designed with open questions for the respondents to interpret and expand for a qualitative response. It aimed to garner information about the developments of the project from initial idea through to realisation, including the rationale behind the collaboration, the purpose of the technology, expected outcomes, potential barriers and benefits to the CH institution, the HE institution and the visitor/user of the technology. It aimed to probe the developmental process, the participants involved, the partnership and collaborative working and the evaluation process.

2.5 Structure of the Document

The first chapter: 3 *Cultural Heritage, The Digital Renaissance and European Funding* focuses on the context in which innovation and experimentation in DT in the CH sector is encouraged, promoted and funded based on the premise that experimentation and innovation is contingent on investment and funding. It situates CH as part of the creative industries and as such makes an important contribution to Europe's economic growth, through creative entrepreneurship and competitiveness.

The chapter gives an overview into the background of funding initiatives by the European Commission, government cultural policies and strategies, public funding bodies and research councils that actively support and finance the research and development of new digital technologies in CH and who actively promote experimentation and innovation in DT, "publicly funded projects that seek to transform cultural artefacts, and our understanding and experience of CH, using new technologies" (RICHES DoW Part A: 18). The chapter focuses on funding projects which include collaborative, interdisciplinary teams, particularly partnerships between the CH sector and the academic research institution which maximise the possibilities and transformative potential of DT for the CH sector "from the lab to the market" (Horizon 2020).[10]

Chapter 4 *Mapping Best Practice in Cultural Heritage and Digital Technologies* addresses the changing role of the CH institution in the twenty-first century and the changes in practice mainly due to the introduction of DT. CH institutions, as public institutions, operate at the intersection of social, cultural, economic and technological change and as such they are pivotal in contemporary society. The chapter maps a range of existing and emerging experimental and innovative DT projects developed through collaborative partnerships between the CH sector and the research institution which constitute best practice. The projects are contextualised within the 'new museology' and current CH practice of enhanced public engagement, interactivity and participation. These include the innovative use of technologies such as virtual reality, augmented reality, holograms and game (or gamification) to access culture. The chapter suggests that the adoption of innovation DT can result in enhanced visitor experience, increased value of museum collections and increased access to collections, and new, novel ways in which to engage visitors. It emphasises the importance of experimentation and innovation and the implementation of new and emerging DT in order for the CH sector to contribute to Europe's creative economy and growth.

Chapter 5: Case study: *ARtSENSE*

Chapter 6: Case study: *Ghosts in the Garden*

The two case studies are concerned with interdisciplinary and collaborative projects between CH institutions, academic research institutions and creative technologists. In-depth analyses of the case-studies include issues such as:

- How the collaboration came about
- The benefits of working in collaboration
- The criteria and stages of development of the technology
- The aims and purpose of the technology
- How the DT was implemented and used by visitors

[10] HORIZON 2020 The EU Framework Programme for Research and Innovation (http://ec.europa.eu/programmes/horizon2020/what-horizon-2020).

The two case studies are similar in that they are both deliberate attempts by CH institutions and research institutions to collaborate in the experimentation of DT and both involved an element of risk. They were however very different in their aims and objectives, in how the project developed and the processes they went through. They reveal that through adopting and experimenting with new digital technologies, new practices emerge. These changes in practice, knowledge and skills can result in the recalibration of relationships between the CH institution and its audiences and between the CH institution and the research institution, one of the aims of the RICHES project.

Both case studies demonstrate that by engaging with new digital technologies and adopting new collaborative working practices can result in many new forms of access, interpretation, social inclusion and enhanced visitor experience. They are also examples of how academic knowledge is no longer confined to the higher institution – rather it is being deployed in society and having an impact: for society, culture and the creative economy. Working in partnership can have benefits for all involved and "narrows the gap between the experimental in the research institution and its practical implementation in the digital economy" (RICHES DOW Part 1: 18).

3. CULTURAL HERITAGE, THE DIGITAL RENAISSANCE AND EUROPEAN FUNDING

> *Digitising our cultural heritage is a gigantic task that requires large investments. According to a study, in total some €100bn will be necessary over time to bring our complete heritage online. This type of effort needs time and the investment will need to be carefully planned and co-ordinated in order to get the best results.*[11]

Cultural institutions throughout Europe have for centuries been considered the 'gatekeepers' of cultural heritage along with the associated issues of power and control. This however is changing. In an information age, DTs have opened up channels of communication, networking on a global scale and access to collections worldwide. DT can be transformative in the way Europe's CH is communicated and made more easily accessible to the public and CH institutions have embraced new technologies to make this happen. The Report of the 'Comité des Sages' states that, "The new information technologies have created unbelievable opportunities to make this common heritage more accessible for all. Culture is following the digital path and "memory institutions" are adapting the way in which they communicate with their public" [12]

This increasing accessibility and communication of European CH through DT can also be considered an important factor in Europe's economic growth. European CH is rich and diverse and attracts millions of visitors each year to CH institutions, monuments, and European cities and is therefore an essential and important contributor to Europe's economy. The digitisation of Europe's CH has supported this, **"**Digitisation breathes new life into material from the past, and turns it into a formidable asset for the individual user and an important building block of the digital economy".[13]

However technology is constantly developing and the CH sector, in order to keep up with pace of change, requires investment and funding,

> *Cultural heritage has already benefitted from significant EU funding, including €3.2 billion from the European Regional Development Fund in 2007-2013. Major conservation works at the Parthenon and Pompeii were among the schemes to receive*

[11] *The New Renaissance*, Report of the 'Comité des Sages' Reflection group on bringing Europe's Cultural Heritage online (2011:1).
https://ec.europa.eu/digitalagenda/sites/digitalagenda/files/final_report_cds_1.pdf
[12] *The New Renaissance*, Report of the 'Comité des Sages' Reflection group on bringing Europe's Cultural Heritage online (2011:1).
https://ec.europa.eu/digitalagenda/sites/digitalagenda/files/final_report_cds_1.pdf
[13] *The New Renaissance*, Report of the 'Comité des Sages' Reflection group on bringing Europe's Cultural Heritage online (2011:1).
https://ec.europa.eu/digitalagenda/sites/digitalagenda/files/final_report_cds_1.pdf

> *support. EU programmes provided a further €1.2 billion for rural heritage and around €100 million for heritage-related research. Cultural heritage is expected to benefit from even higher EU investments in 2014-2020, for example through the European Structural and Investment Funds (with a total budget of €351 billion for regional policy), Horizon 2020 (€80 billion for research) and Creative Europe (€1.5 billion for cultural and creative industries).*[14]

This quotation demonstrates the support and some of the main funding for CH development and demonstrates the commitment of the EU to the importance of promoting and preserving Europe's CH. Throughout Europe there is a drive towards the integration of DT in the CH sector supported by a range of government initiatives and agendas to promote the development and application of innovative technologies in how Europe's CH is accessed, communicated, preserved and interpreted. This is concomitant with the changes in CH institutions throughout Europe in becoming more interactive, participatory and more democratic in their relationships with their visitors to enhance their public engagement agendas. In a recent European Parliament Resolution '*Towards an Integrated Approach to Cultural Heritage for Europe'* (September 2015), Section N stated that funding opportunities through EU programmes in areas related to CH were fragmented and called for a single platform for funding opportunities for CH (Section 7a). This deliverable can be considered as a contribution to that strategy.[15]

DT is continuously developing and becoming more sophisticated and the visitors to CH institutions are also evolving and becoming more digitally literate. As DT becomes more mobile, personal and easily accessible, CH visitors expect a digitally enhanced experience as they would do in other sectors of society. Research, experimentation and innovation in DT for the CH sector therefore becomes essential if the CH sector is to maintain their existing audience and attract a new generation of users and this requires continued investment "to ensure that Europe experiences a 'Digital Renaissance' with the caveat that if this doesn't happen Europe many fall into a 'digital dark age'.[16]

The aim of this chapter is to map some of the European initiatives, strategies and funding bodies that have been put in place to support and promote research, innovation and digitisation in the CH sector to secure Europe's competitiveness.

---

[14] Heritage Portal.com '*EC Communication:Towards an integrated approach to cultural heritage for Europe'*, European Commission Press release Brussels, 22 July 2014 [accessed 22/07/2015].
[15] European Parliament Resolution: *Towards an Integrated Approach to Cultural Heritage for Europe*: Section N and 7a. Available at: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2015-0207+0+DOC+PDF+V0//EN
[16] *The New Renaissance*, Report of the 'Comité des Sages' Reflection group on bringing Europe's Cultural Heritage online (2011:1)https://ec.europa.eu/digitalagenda/sites/digitalagenda/files/final_report_cds_1.pdf

It considers examples of funding that put an emphasis on partnerships between research institutions and CH institutions and that promote interdisciplinary collaborations and "publicly funded projects that seek to transform cultural artefacts, and our understanding and experience of CH, using new technologies" (RICHES DoW, Part A: 18). It links CH, experimentation and innovation in digitisation with economic growth, collaborative partnerships, entrepreneurship and funding that supports CH projects and emerging technologies relevant for a digital economy, "from the lab to the market" (Horizon 2020).

3.1 Europe as a Laboratory for DT and CH Innovation

Emerging technologies include the Internet of Things (IoT) based on wireless sensor networking technologies and Radio Frequency Identification Tags (RFITs) and the Semantic Web in which an 'intelligent' internet is embedded in all aspects of life and uses smart applications such as mobile and wearable devices to ensure that everyone can be connected anytime and anywhere through ubiquitous and pervasive computing. An important aspect of the IoT is the integration with the internet infrastructure such as the 'cloud' which has implications in the future development of DT and how it is used in the CH sector. Ubiquitous computing has been enabled by the increasing use of mobile 'smart' devices and this development in technology has been recognised as a driver for change in the European CH sector,

> *Some estimates suggest that, by 2020, there will be 50 billion mobile wireless devices connected to the Internet worldwide, with the number of devices potentially rising to 500 billion – this raises many important issues for stakeholders to consider. Economies and societies will be increasingly intermeshed with devices that continuously communicate with each other and provide information to users.*[17]

This recognition of rapid and constantly evolving DT as an important part of CH and Europe's economic growth has resulted in initiatives to support and fund emerging experimental and innovative technologies in the CH sector. They assert that these developments in DT and the changes it will bring about have enormous potential to make a valuable contribution to Europe's economic development. This deliverable underlines the importance for the CH sector in research and experimenting with new and innovative DT to keep abreast of the evolving technologies in order to remain relevant for a contemporary digital audience.

[17] *JPI Cultural Heritage and Global Change: Report on Drivers of Change and the Future of Cultural Heritage*: A Review to support the development of the Strategic Research Agenda. Centre for Research in Futures and Innovation, University of Glamorgan, UK with CM International (no date) page 5. Available at: http://www.jpi-culturalheritage.eu/wp-content/uploads/JPI-Cultural-Heritage-Drivers-Synthesis-Report-final-version-to-be-published.pdf

The Digital Agenda for Europe 2010-2020

The Digital Agenda for Europe (2010-2020) is a wide-ranging strategic plan to enable and ensure that Europe has a flourishing digital economy by 2020 and that EU citizens can benefit from the Digital Revolution. This aims to increase Europe's business processes, competitiveness and technological development including,

- Cloud computing: centralised data storage and processing
- From experimentation to future internet: Looking beyond the present to future technologies
- The Internet of Things (IoT)
- Network technologies
- Convergence and interoperability of technologies

This is relevant for this deliverable in the recognition of the need for experimentation and innovation in future technologies and in funding research projects in heritage innovation,

> *Research projects funded by the European Commission are spearheading future networks which are fast, flexible and ever-responsive to demands from both humans and machines for access to content, apps and services relevant to the context and location of the user. This is how the future internet is evolving: as an internet of services, things and infrastructure. From smart appliances that talk to each other to clothes that monitor our health; from cars that cannot crash to mobile technologies and cloud platforms that run our businesses.*[18]

In May 2014 EU Culture Ministers called for the Commission to "pursue the analysis of the economic and social impact of cultural heritage in the EU and contribute to a development of a strategic approach". It aimed to help Member States and stakeholders to make the most of the "significant support for heritage available under EU instruments, progress towards a more integrated approach at national and EU level, and ultimately make Europe a laboratory for heritage-based innovation".[19]

[18] https://ec.europa.eu/digital-agenda/en/future-internet [accessed 1/06/2015]
[19] Heritage Portal.com - EC Communication "*Towards an Integrated Approach to Cultural Heritage for Europe*" European Commission Press release Brussels, 22 July 2014. [accessed 22/07/2015] http://www.heritageportal.eu/News-Events/Press-Releases/EC-Communication-%E2%80%9CTowards-an-integrated-approach-to-cultural-heritage-for-Europe%E2%80%9D.html.

The Digital Agenda for Europe includes the Future and Emerging Technologies (FET) programme which provides "a unique combination of high risk, long term, multidisciplinary and collaborative frontier research, which lays the foundations for radically new, next generation technologies. It converts proofs of concept into industrial applications and systems".[20]

FET invests in innovative research in DT that is transformative and has benefits for European society and economy. It is based on interdisciplinary working and collaboration between a range of sciences with the arts and humanities. Its main aim is to nurture innovative and emerging trends in future technologies across a wide range of disciplines.

The Digital Single Market

The *Digital Single Market Strategy* adopted by the European Commission in May 2015, aims to enhance Europe's position as a world leader in the digital economy by opening up digital opportunities for people and businesses. A Digital Single Market is one in which the "free movement of persons, services and capital is ensured and where the individuals and businesses can seamlessly access and exercise online activities under conditions of fair competition, and a high level of consumer and personal data protection, irrespective of their nationality or place of residence".[21]

The *Digital Single Market* was adopted due to the fact that "315 million Europeans use the internet every day and that it can create 415 billion euro in additional growth, hundreds of thousands of new jobs, and a vibrant knowledge-based society".[22]

One of its objectives is to invest in research and Innovation in DT to boost growth and jobs and to encourage Private-Public partnerships and training in digital skills.

The Joint Programme Initiative on Cultural Heritage and Global Change (JPI-CH)

> *European cultural heritage is of exceptional importance. It enriches the lives of its citizens, contributes to the individual and mutual identity of European nations and has significant economic impact as it attracts millions of visitors a year from all over the world.*[23]

[20] https://ec.europa.eu/digital-agenda/en/future-emerging-technologies-fet [accessed 24/08/2015]

[21] https://ec.europa.eu/digital-agenda/en/digital-single-market#Article [accessed 24/08/2015].
[22] https://ec.europa.eu/digitalagenda/sites/digitalagenda/files/digital_single_market_factsheet_final_20150504.pdf [accessed 24/08/2015].
[23] JPI Cultural Heritage and Global Change: Strategic Research Agenda (www.jpi-culturalheritage.eu) JPI on Cultural Heritage is supported by European Commission Coordination Action JHEP Project, Grant Agreement n° 277606.

Launched in 2010, the main objective of JPI on Cultural Heritage,

> *Addresses the strong relationships that link cultural heritage, conservation, technological innovation and economic development within the dynamic framework of the challenges, competitiveness and opportunities presented by an increasingly globalised, environmental and security-conscious society.*[24]

The European Commission defines joint programming as identifying a common vision, defining a strategic research agenda and implementing this through a Joint Programme Initiative. It encourages member states and associated countries to collaborate and participate in projects in the protection of CH under global change conditions and that respond to major societal challenges such as climate change, the security of CH and the rapid changes induced by technology. It aims to streamline and coordinate national research programmes for efficiency, to avoid duplication with the objective to protect CH and to stimulate Europe's future economic growth and jobs. The Heritage Portal is the communication platform for disseminating all forms of information regarding JPI-CH.[25]

An important aspect of the JPI-CH is the development of the Strategic Research Agenda (SRA) which aims to be a forward-thinking agenda concerned with the potential of future research,

> *This Strategic Research Agenda will create a foundation for innovative research as well as inspiration for new researches and skills in the fascinating field of protecting and fostering our common tangible, intangible and digital cultural heritage.*[26]

The *Strategic Research Agenda* supports collaborative and interdisciplinary work and states,

> *The overwhelming need is for research to be truly integrative and provide opportunities to explore the tangible, intangible and digital forms of cultural heritage. Future research should involve collaboration and work across boundaries - disciplinary, conceptual, theoretical, methodological and international.*[27]

[24] JPI Cultural Heritage: A Challenge for Europe (www.jpi-culturalheritage.eu).
[25] The Heritage Portal has received funding from the European Union Seventh Framework Programme (FP7 2007-2013) under grant agreement no. 277606. - See more at: http://www.heritageportal.eu/About-Us/#sthash.JLxMbhRN.dpuf.
[26] Antonia Pasqua Recchia, Coordinator of the JPI Cultural Heritage. Foreword in JPI Cultural Heritage and Global Change: Strategic Research Agenda (www.jpi-culturalheritage.eu).
[27] JPI Cultural Heritage and Global Change: Strategic Research Agenda (www.jpi-culturalheritage.eu).

This is important for this deliverable which is based on best practice in the CH sector through collaborative partnerships with academic research institutions. The *Strategic Research Agenda* research priorities are:

- **Developing a reflective society**. This is broadly based on recognition that the world is changing and that research questions, approaches, methods and reporting need to reflect this change.
- **Connecting people with heritage**. This concentrates on exploring access by addressing themes and issues that enable people and communities to connect with heritage, underpinned by sustainable management plans.
- **Creating knowledge**. This involves deepening our understanding of the context in which cultural heritage exists and is formed, and developing innovative approaches, applications and tools that will create added value for society from cultural heritage.
- **Safeguarding our cultural heritage resource**. This explores how we can protect our heritage and the research that is required to support protection.

Priority areas for delivery include:

- Collaborative and transdisciplinary/interdisciplinary research
- Knowledge exchange (experience and best practice)
- Involvement of partners
- Applying and embedding new technologies and tools
- Exploring new methods/research
- Strategies/Policies[28]

The ENUMERATE network supports the European Commission's ambition for smart, sustainable growth by developing the first comprehensive body of evidence about the scale, cost and impact of culture-sector digitisation and is addressed in RICHES deliverable 5.3 *Fiscal Issues in the Digital Age and CH.*[29]

The European Commission– Framework Programme

One of the main funding sources for multi-disciplinary research in Europe is the Framework Programme (FP) of the European Commission (EC). From 1984 to 2013 there have been seven FPs and as well supporting research, from the very beginning "digital technologies became an important issue" (Navarette 2014: 156).[30]

[28] JPI Cultural Heritage and Global Change: Strategic Research Agenda (www.jpi-culturalheritage.eu).
[29] http://www.enumerate.eu/fileadmin/ENUMERATE/stakeholder/ENUMERATE-Stakeholder-02-Web.pdf.
[30] For a detailed outline of the themes in each of the seven Framework Programmes see Navarette 2014.

The theme for FP7 (2007-2013) was Research and Technological Development and had a total budget of over 50 billion Euro, which reflects the importance of the programme. In addition it aimed to respond to Europe's employment needs and competitiveness in a global knowledge economy. FP7 had a larger budget than the previous six FPs and had two main goals:

- to strengthen the scientific and technological base of European industry
- to encourage its international competitiveness, while promoting research that supports EU policies.[31]

FP7 emphasises collaborative research and partnerships between different countries to counter the fragmented nature of the European research landscape. It also advocates industry-academia partnerships.

HERA JPI

HERA (Humanities in the European Research Area) organise a *Joint Research Programme* (*HERA JRP*) based on the Knowledge Transfer (KT) of academic research and its relevance to external stakeholders such as CH institutions, policy makers, business and education. *HERA JRP* is a pan-European project and is financially supported by the European Community FP7 2007-2013 under the Socio-economic Sciences and Humanities Programme. It provides opportunities for collaborative KT and networking to bring academics and non-academics together. *HERA JPI* funds a range of projects that brings together university scholars throughout Europe under the theme 'Humanities as a source of Creativity and Innovation'. Intrinsic to each project is a range of KT activities such as exhibitions (virtual and physical), workshops, local, national and international conferences, website, podcasts, databases, performances and Open Access publishing. *HERA* are concerned with the impact of University research and created *HERAVALUE: Measuring the Societal Impacts of Universities' Research into Arts and the Humanities.*

HERA JRP is also funded by: The Arts and Humanities Research Council (AHRC), UK; Academy of Finland (AKA); The Danish Agency for Science, Technology and Innovation (DASTI); Estonian Science Foundation (ETF); The National Research Fund (FNR), Luxembourg; Austrian Science Fund (FWF); The Croatian Academy of Sciences and Arts (HAZU); The Irish Research Council for the Humanities and Social Sciences (IRCHSS); Ministry of Higher Education, Science and Technology (MHEST), Slovenia; Netherlands Organization for Scientific Research (NWO); The Icelandic Centre for Research (RANNIS); The Research Council of Norway (RCN); The Swedish Research Council (VR).

[31] Further information available at: http://ec.europa.eu/research/fp7/pdf/fp7-inbrief_en.pdf

Horizon 2020

The EUs current Framework Programme is *Horizon 2020* (2014-2020) although there are still programmes running under FP7. It has a budget in excess of 80 billion Euro over a period of seven years. The first *Horizon 2020* grants were signed in 2014 and hundreds of new projects are being added every month. Research is recognised as an investment in the future and as a driver for economic growth and as a means to create employment. Research excellence is coupled with innovation and any barriers to innovation should be removed to help to create a genuine single market for knowledge, research and innovation. It aims to support experimental and innovative ideas, taking them "from the lab to the market". [32]

Reports for *Horizon 2020* projects will be available on the CORDIS website, the European Commission's primary public repository and portal to disseminate information on all EU-funded research projects and their results in the broadest sense. It contains over 100,000 EU-funded research projects and results stretching back 25 years and now extending its services to Horizon 2020 projects.[33]

DARIAH-EU

DARIAH-EU, the Digital Research Infrastructure for the Arts and Humanities, aims to enhance and support digitally-enabled research and teaching across the humanities and arts. Its mission is to develop networks of communities to work collaboratively to bring together individual state-of-the-art digital Arts and Humanities activities across Europe. One of the benefits of researchers who join *DARIAH-EU* is to be supported to experiment and innovate in collaboration with other scholars. It is relevant for this deliverable not only in its support for DT research-based support but also in its promotion of collaborative and networked working -and activities centred around research communities and develops a research infrastructure for sharing and sustaining digital arts and humanities knowledge. As outlined on its website, "It will preserve, provide access to and disseminate research that stems from these collaborations and ensure that best practices, methodological and technical standards are followed"[34]

Key benefits of participation in *DARIAH-EU* could include:

- Increased visibility of national research at the European level
- Increased international collaboration opportunities; enhancing exchange of knowledge, skills, expertise, training opportunities and good practice
- Increased potential for the sustainability of the outcomes digital research projects after the end of project funding, helping to ensure the sustainability of tools and services

[32] http://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020 [accessed 05/05/2015].
[33] http://cordis.europa.eu/home_en.html [accessed 14/09/2015].
[34] https://dariah.eu/about.html [accessed 11/07/2015].

- Increased access to research data, tools and services via the DARIAH infrastructure
- Increased influence at the European and international level and increased
- Opportunities for funding

In August 2014 *DARIAH-EU* was established as *DARIAH-ERIC*, a European Research Infrastructure Consortium (*ERIC*) and aims to facilitate the long-term sustainability of the European arts and humanities research community and beyond. The host country for *DARIAH-ERIC* is France and the founding members are Austria, Belgium, Croatia, Cyprus, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Serbia and Slovenia.

NeDiMAH

NeDiMAH (Network for Digital Methods in the Arts and Humanities) is one of the collaborative networks supported by *DARIAH-EU* and was launched in May 2011 for four years until April 2015. It was a European Science Foundation Research Network Programme (ESF) and organised a series of activities and networking events on the practice of, and evidence for, digital research in the arts and humanities across Europe.

NeDiMAH activities and research produced three key outputs:

- A map visualising the use of digital research across Europe
- An ontology of digital research methods in the humanities (NeMO: the NeDiMAH Methods Ontology)
- A collaborative, interactive online forum for the European community of practitioners active in this area[35]

During the term of the project the Network has organized 47 activities, “exploring key areas of theory and practice in a number of methodological areas, including: the analysis of time and space, visualization, linked data, large scale data analysis, editing, manuscript imaging, temporal modelling, and scholarly communications”.[36]

Their objective was to understand the impact of DT on transforming scholarship in the arts and humanities and “the potential for extending the benefits of digital research to the creative industries, the commercial sector, and public policy and planning”. [37]

One of the most important aspects was the collaboration between science and technology disciplines with the CH sector such as libraries, archives and museums and their links to *DARIAH-EU* and *CLARIN*.[38]

[35] Beyond the Digital Humanities http://www.nedimah.eu/reports/beyond-digital-humanities
[36] Beyond the Digital Humanities http://www.nedimah.eu/reports/beyond-digital-humanities
[37] Beyond the Digital Humanities http://www.nedimah.eu/reports/beyond-digital-humanities

NeDiMAH projects include a range of disciplines including anthropological, genealogical, historical, archaeological, literary, sociological, museological, geographic and linguistic applications. For example, they have included visualisation technologies and how it impacts on perception and helps to construct new understanding and knowledge and new methods for manuscript imaging such as RTI imaging, which by replicating angled lighting allows the scholar to see details such as scratched glosses or flaking of pigment which cannot be seen with conventional digital imaging. Although they are aware that these experimental methods can create new methods of working and new knowledge, they create challenges for the conservation of the material manuscripts by repeated examination of them using the new experimental techniques. The manuscripts have undergone 'mass digitisation' and they suggest it is now time for a more "bespoke 'slow digitisation' provision of images that are outputs of new types of capture"

The final *NeDiMAH* event 'Beyond the Digital Humanities' was held on 5 May 2015 in London. The event had presentations on topics including 'Information Conceptualisation and Visualisation', 'Space and Time', 'Linked Data and Ontological Methods' and 'Overlaps between Network Analysis and the Digital Humanities'. The event made clear that a transnational approach is essential, as research on networks in history has yielded different approaches between Europe and the USA. The event also showcased the powerful connections that already exist between historians and computer scientists, and made recommendations for future collaborations.

In addition to European overarching policies and strategies for funding each member state have their own public funding bodies.

The Arts and Humanities Research Council (AHRC)

The Arts and Humanities Research Council (AHRC) in the UK is a non-departmental public body sponsored by the Department for Business, Innovation and Skills, along with the other UK Research Councils.

Heritage has been identified as a priority area for support by the AHRC and they have worked in partnership with other agencies in the UK and internationally (For example the AHRC/EPSRC Science and Heritage Research programme and the Joint Programming Initiative (JPI) on Heritage and Global Change as previously discussed). Heritage is considered a vibrant, innovative, collaborative and cross-disciplinary research field which the AHRC acknowledge is an important contribution to the

[38] CLARIN is the Common Language Resources and Technology Infrastructure, which aims to provide easy and sustainable access for scholars in the humanities and social sciences to digital language data (in written, spoken, video or multimodal form), and advanced tools to discover, explore, exploit, annotate, analyse or combine them, wherever they are located http://clarin.eu/content/about-clarin [accessed 24/08/2015].

creative economy along with the development of partnerships and cross-disciplinary collaborative working.

The AHRC Knowledge Exchange Partnership was developed as part of their funding portfolio to support and encourage researchers to collaborate with external agencies, both public and private. The aim was to create opportunities to engage in knowledge exchange, to encourage co-creation and co-production of research agendas and to enable academic research to have a wider impact in the creative economy and society. They publish a range of advice and reports regarding good practice and partnerships.[39]

The AHRC Digital Transformations project aimed to attract innovative and cutting-edge proposals for funding. The first stage was from February to August 2012 and included 18 projects each with a budget under £30,000. The second stage began in 2012 and included the Large Grant Programme. Digital Transformations was not just about new things but how research is conducted and communicated not just within the timeframe of the project but after it. It aimed to involve a disruption and questioning of established notions of arts and humanities disciplines and ways of working,

> *It will encourage arts and humanities researchers to work with scientists in developing new concepts for digital technologies to explore our artistic and cultural heritage. It will show how the theoretical insights generated by the arts and humanities enable us to better understand the profound changes currently occurring in identity, culture and society. Researchers in the arts and humanities will create new relationships with creative and cultural businesses, memory institutions and technology producers.*[40]

It was concerned with three areas of transformation:

- *Transformations in cultural life and cultural artefacts:* Digital technologies and cultures lead to new objects of study – new communities, networks, devices, texts and artworks that should be the focus of innovative academic research.
- *Transformations in theories, approaches and tools:* These developments lead to transformations in research practice – suggesting ways of thinking, connections, and ways of working, which change the practices and processes of research.

[39] The AHRC along with Creative England have published a report: 'Connecting and Growing Creative Businesses through Engagement with Higher Education Institutions' (2013). PDF available to download at: http://www.ahrc.ac.uk/documents/project-reports-and-reviews/connecting-and-growing-creative-businesses-through-engagement-with-higher-education-institutions-final-report-february-2013/
The AHRC 'Partnership Working in the Arts and Humanities: A guide to Good Practice'. PDF available to download at: http://www.ahrc.ac.uk/documents/guides/partnership-working-in-the-arts-and-humanities/

[40] Professor Andrew Prescott, AHRC, Digital Transformations Theme Leadership Fellow in NeDiMAH: Beyond the Digital Humanities, NeDiMAH Booklet PDF 2015.

- *Transformations in communication, engagement and participation:* The ways in which research can be shared and engaged with is also transformed by digital technologies, which offer compelling new avenues and opportunities.[41]

These areas overlap and are interrelated and the projects supported included subjects which ranged from performance, design, literature, publishing cross-cut with themes such as co-curation, collaboration, translation, games, platforms and IPR. As described by David Gauntlett,

> *The term 'digital transformation' is applicable across the breadth and width of AHRC-funded research. Its impact is plural, transversal and generative: reaching from situations where digital media enables the broadening of audiences for funded research to the emergence of singularly new practices which are embedded in and integrated with rapidly changing media.*[42]

The AHRC actively supports entrepreneurial talent and promotes growth and innovation achieved through its main aim of connecting the best research in the arts and humanities with a range of creative and cultural organisations to generate new knowledge exchange that benefits the cultural economy. It has committed £16 million (80% Full Economic Costs) during the period 2012-2016 to support four Knowledge Exchange Hubs for the Creative Economy.[43]

The *Knowledge Exchange Hubs* are considered centres of excellence,

> *Putting Knowledge Exchange at the very heart of its strategy the AHRC works to ensure that arts and humanities academic interests are diversified and enhanced through opportunities to engage in knowledge exchange and partnership work across our entire funding portfolio; to encourage co-creation and co-production of research agendas; to have a significant and transformative effect on the creative and cultural life and health and well-being of the nation; and to enlarge the contribution to the arts, public engagement and policy formation.*[44]

[41] Arts and Humanities Research Council –Digital Transformations Final Report 2012. http://www.digitaltransformations.org.uk/main/wp-content/uploads/2012/10/AHRC-DT-final-report-October-2012.pdf.
[42] Gauntlett, D (2012) *Onwards and Upwards for Digital Transformations* http://www.digitaltransformations.org.uk/onwards-and-upwards-for-digital-transformations/
[43] http://www.ahrc.ac.uk/innovation/knowledgeexchange/ [accessed 15/08/2015]
[44] http://www.ahrc.ac.uk/innovation/knowledgeexchange/ [accessed 15/08/2015]

The four Knowledge Exchange Hubs are:

- ***REACT*** (Research and Enterprise in the Arts and Creative Technologies) (University of the West of England Bristol in partnership with the University of Bristol, University of Exeter, University of Bath, University of Cardiff, and the Watershed Arts Trust)
- ***The Creative Exchange*** (Lancaster University in partnership with the University of Newcastle and the Royal College of Art)
- ***Design in Action*** (University of Dundee in partnership with Edinburgh College of Art at the University of Edinburgh, The Glasgow School of Art, Gray's School of Art at the Robert Gordon University, University of Abertay and St Andrews University)
- ***Creative Works London*** (Queen Mary University of London in partnership with Birkbeck College, Central Scholl of Speech and Drama, City University, the Courtauld Institute, Goldsmith College, Kingston University, Guildhall School of Music and Drama, King's College London, Roehampton university, Royal Holloway, School of Oriental and African Studies, Trinity Laban Conservatoire of Music and Dance, University of the Arts and the University of London's Centre for Creative Collaboration.

NESTA (UK)

NESTA (National Endowment for Science Technology and the Arts) (www.nesta.org.uk) is an independent charity and the UK's innovation foundation which supports ideas through concept to realisation through providing investments and grants to encourage and support research, networks and skills. They advocate innovative-led growth for the creative industries in the UK and advocate that creative organisations and universities should experiment with the next generation of DT and share their experience.[45]

The Digital R&D Fund for the Arts

In 2012, the *Digital R&D fund for the Arts* was launched by a partnership between the Arts and Humanities Research Council (AHRC), Arts Council England (ACE) and NESTA. The seven million GBP programme aimed to support arts and cultural organisations across England to work with digital technologies, to expand their audience reach and engagement and/or explore new business models for the CH sector. In addition to developing experimental and innovative DT the criteria for funding was based on collaboration between,

- CH organisations or institutions
- Technology companies
- Academic research partners

[45] Hasan Bakhshi, Ian Hargreaves and Juan Mateos-Garcia (2013) Nesta's *Manifesto for the Creative Economy.* http://www.nesta.org.uk/publications/manifesto-creative-economy

Public-funded projects should be made widely available for access and re-use and this was to ensure that learning from the project could be disseminated to as wide an audience as possible. The fund had six priority themes:

- user generated content and social media
- digital distribution and exhibition
- mobile location and games
- data and archives
- resources
- education and learning

In 2013, Arts Council England, the Arts and Humanities Research Council and Nesta launched the Digital Culture Study: an annual survey tracking digital technology use by arts and cultural organisations in England from 2013 to 2015. Established alongside the Digital R&D Fund for the Arts, the research provides quantitative evidence about the use, importance and impact of digital technologies and found that,

- almost three-quarters saw digital as essential to their marketing
- almost 60% viewed it as essential for preserving and archiving, and for their operations
- Almost half (47%) were creating 'born digital' works native to, and created for, the digital space
- one third (32%) saw digital technology as essential for distributing and exhibiting their work.

Organisations that are leading the way in prioritising and deploying DT as an embedded part of their organisational strategy have been labelled the 'cultural digirati'. These are more likely to be experimental and innovative in their use of DT and more likely to report an increase in their revenue.[46]

Examples of projects that the Digital R&D Fund have supported include the Tate Modern who produced new interactive digital projects '*Bloomberg Connects'* to invite visitors to connect with art, artists and other visitors in new ways and make their ideas visible around the gallery and the Royal Opera House in London developed a free hybrid app to build engagement with their growing digital and broadcast audiences. To help arts and culture organisations explore new business model opportunities the Digital R&D Fund have published guides and reports such as,

- 'Making Digital Work: Business Models: sharing the learning from the Digital R & D Fund for the Arts'

[46] Digital R&D Fund for the Arts: *Digital Culture: How Arts Organisations in England use Technology.* http://artsdigitalrnd.org.uk/wp-content/uploads/2014/12/Digital-Culture-2014-Research-Report2.pdf

http://artsdigitalrnd.org.uk/wp-content/uploads/2015/06/DigitalRDFundGuide_Business.pdf

- '5 Ways to Build Successful Relationships with Academic Researchers' http://artsdigitalrnd.org.uk/features/5-ways-to-build-successful-relationships-with-academic-researchers
- Report: 'How Arts and Cultural Organisations in England use Technology' (2014) http://artsdigitalrnd.org.uk/wp-content/uploads/2014/12/Digital-Culture-2014-Research-Report2.pdf

NATIVE is the journal for the Digital R&D for the Arts and the website contains information on all funded projects. The full report can be downloaded at: native.artsdigitalrnd.org.uk/digitalcultureresearch.

Conclusion

This chapter has outlined some of the European initiatives, policies and strategies to fund, encourage and support experimental and innovative DT and to create opportunities in the CH sector. Many of these advocate and encourage cross and inter-disciplinary collaborations including partnerships between the CH sector, technology companies and academic research institutions which "help to bridge the gap between the experimental in the research institution and its practical implementation in the digital economy" (RICHES DoW, Part A: 18). This also contributes to the social aims of the academic research institution in ensuring that research has a social impact and is no longer confined in the institution.

The development of these European financial initiatives and strategies reflect the interest and the importance of experimentation and innovation in DT and the recognition of DT as an important driver of change in the CH sector. It also reflects the important status of the CH sector in the European economy and the potential to make a vital contribution to Europe's creative economy,

> *The sheer diversity of projects and areas of research in the cultural heritage arena means that the knowledge, skills and expertise of researchers is also helping the innovation of products, services and business models, all of which will help Europe's future economic growth and jobs. This is essential if we are to remain competitive in the global marketplace and improve the quality of life in Europe.*[47]

[47] JPI Cultural Heritage and Global Change: Strategic Research Agenda (www.jpi-culturalheritage.eu)

As discussed, the European Commission's Digital Agenda for Europe is concerned with the growth of the European Union by 2020. It proposes to "better exploit the potential of Information and Communication Technologies (ICTs) in order to foster innovation, economic growth and progress".[48]

Experimentation and innovation is however, contingent on funding and support. The value of European funding and national funding bodies is in allowing time to undertake research and to experiment with ideas and concepts as described by an academic funded by the AHRC in the UK,

> *The AHRC allows people the time, the space, and the reflection to really understand an issue and to really innovate solutions. I think it has radically altered the way the arts and humanities function in the university sector. It's given us credibility and parity with the sciences.*[49]

The funding bodies have supported emerging technologies which have implemented changes in practice the CH sector such as interactivity, co-creation and participation - creating social and cultural value for the visitor and economic value for European CH demonstrating that CH has social and cultural value as well as economic value. In September 2015 the European Parliament published a Resolution which highlighted the importance and significance of CH and emphasised that research, innovation and new technologies are essential for enabling Europe's CH to be more accessible to the people. It asks the Commission to continue the funding, support and promotion of CH and to "set up a single EU portal dedicated to tangible and intangible cultural heritage, bringing together all the information programmes funding cultural heritage".[50]

The initiatives and funding have allowed for experimentation, innovation and developments and the implementation of emerging technologies in the CH sector through collaborative partnerships between the CH sector and the academic research institution which is the focus of the next chapter. The implementation of innovative technologies in the CH sector will help to ensure that Europe remains competitive and entrepreneurial.

[48] https://ec.europa.eu/digital-agenda/en/digital-agenda-europe-2020-strategy [accessed 24/08/2015]
[49] Professor Georgina Folett, Director, Design in Action, Dundee University. http://www.ahrc.ac.uk/research/readwatchlisten/filmsandpodcasts/knowledgeexchangehubstwoyearsin/ [accessed 15/08/2015].
[50] European Parliament Resolution: *Towards an Integrated Approach to Cultural Heritage for Europe*: Available at:http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2015-0207+0+DOC+PDF+V0//EN.

4 MAPPING BEST PRACTICE IN CULTURAL HERITAGE AND DIGITAL TECHNOLOGIES

Introduction

> *Member States should promote ways to turn digitisation into new development opportunities for European firms, for example through regional clusters of businesses in partnership with cultural institutions, knowledge partnerships between cultural institutions and universities, or through strategic partnerships at European or international level in the area of new technologies and applications in relation to cultural heritage.*[51]

From 'tweeting the dead', meeting holograms of historical characters, engaging with virtual and augmented reality to the use of games (gamification) to communicate culture are just some of the examples of innovative and experimental DT that have been implemented in the CH sector. Applications (apps) have been developed for all aspects of accessing, communicating, interpreting and preserving culture which aim to increase the CH visitors' understanding and knowledge of subjects including art history, theme-parks and gardens. These utilise the increasing use of mobile or wearable technology: smartphones, tablets and iPads exemplifying the potential (and predictable) future of DT and mobile internet in accessing information online anywhere, anytime and by anyone. It also reflects the increasing awareness of CH sector and their interest and commitment to providing an engaging experience for their visitors through experimentation and innovation in DT. As stated in the above quotation, in many cases, these new DT have been developed in collaboration with external agencies and this deliverable is specifically concerned with knowledge partnerships between cultural institutions and academic research institutions to turn digitisation into new opportunities.

This chapter maps a range of existing and emerging experimental and innovative DT projects developed through collaborative partnerships between the CH sector and the research institution that constitute best practice. It emphasises the importance of innovation and implementing new and emerging DT for the CH sector to contribute to Europe's creative economy and growth.

It argues that the 'new museology' is not just about a change in practice and different modes of working but that social change and participation in CH has been brought about through the use of experimenting with new technology.

[51] The New Renaissance: Report of the 'Comité des Sages' Reflection group on bringing Europe's Cultural Heritage online (2011: 5). Available at: https://ec.europa.eu/digitalagenda/sites/digitalagenda/files/final_report_cds_1.pdf

In this sense new technology has the potential to be transformative in how we access, communicate and disseminate European CH. This transformation also affects CH professionals in recalibrating their relationship with other CH institutions, external agencies, such as research academies and, most importantly, their audience. Indeed it can be argued that the future of CH and DT are fundamental to these new relationships.

4.1 CH Institutions as Social Institutions

> *Digital technologies are disrupting established practices and creating new opportunities for innovation across the creative economy. Some arts and cultural organisations are experiencing transformational impacts, using digital technology to reach bigger audiences than ever before.*[52]

CH institutions, as public institutions, operate at the intersection of social, cultural, economic and technological change and as such they are pivotal in contemporary society. In considering the development of experimental and innovative DT in the CH sector and the collaboration with research institutions also involves the intersection and the relationships of the people involved: CH professional, academic researchers and CH visitors and users and the recalibration of these relationships.

Technology and experimentation are terms usually associated with scientific disciplines rather than the humanities. Macdonald and Basu (2007), however, argue that the realms of museum exhibition and scientific experiments are not so distinct. They highlight that the world's first university museum, The Ashmolean in Oxford, UK (1683), was also a venue for the public demonstration of scientific experiments and that experiments can be a transformative process for all involved, including the materials, in this case digital technology. For them, the museum can be a site of experiment or a laboratory for "the generation rather than the reproduction of knowledge and experience" (Macdonald and Basu 2007: 2). This is apt for this deliverable which examines best practice in the CH sector with reference to innovative and experimental DT and how it can generate new knowledge and understanding of European CH and the potential of it to transform CH practice, to bring about change and to recalibrate relationships in the CH sector and its pubic. Innovation and experimentation in DT is not about the reproduction of existing knowledge(s) in new and novel ways but the creation of new knowledge(s) not only from curators and CH professionals but from people and the users of CH who have diverse backgrounds.

[52] http://artsdigitalrnd.org.uk/wpcontent/uploads/2013/11/DigitalCulture_Summary.pdf [accessed 02/09/2015].

Through experimenting with innovative technology, particularly in enhancing the experience of CH in an interactive and participatory way, can attract a new generation of visitors and therefore increase the potential of the CH sector to contribute to Europe's economy.

CH Institutions and Digital Technologies

In the past, museums have been variously described as a 'mausoleum' and a form of 'entombment' (Elsner and Cardinal 1994:155), and as a' living fossil' (Vergo 1989:4). The objects in the museum which are part of Europe's CH have been described a 'carceral' confined in the museum (Foucault 1995). This chapter argues against this and positions the museum as a dynamic and ever-evolving CH institution. In recent years the 'new museum' has been described as a cultural centre (Message 2006), the participatory museum (Simon 2010), the dialogic museum (Tchen 1992 in Karp, Creamer and Levine), the museum as inclusive and empowering, and the museum as a medium of communication (Hooper- Greenhill 1995: 4-7). This literature reflects the changing nature and shifting practice in museums, in particular the idea of the 'participatory museum' (Simon 2010) brought about by the implementation of a variety of DTs which reflect changes in European society.

The introduction of DT into CH institutions has also been addressed in a growing literature: Fiona Cameron and Sarah Kenderdine (eds.), *Theorizing Digital Cultural Heritage* (2007/2010); Loïs Tallon and Kevin Walker (eds.), *Digital Technologies and The Museum Experience* (2008); Ross Parry (ed.) *Museums in a Digital Age* (2010). DT in the museum has been described as 'a source of power' (Kidd, 2014), 'the contemporary museum as a media space' (Russo 2012) and for Ross Parry 'media defines the museum' (Parry 2007).

It could be argued that CH institutions have always embraced innovative technology. For example, Michelle Hennings has examined the introduction of spotlights in the 1920s and the introduction of photography and video into the museum (Hennings in Macdonald and Basu 2007).

There has been a growing interest in the use of technology in the CH sector since the advent of the internet and this interest has gained momentum since the turn of the twenty-first century. Early devices such as touchscreen computers in an exhibition and personal digital assistants (PDAs) have been used in a variety of ways to:

- Support the interpretation of artworks
- Learning and education
- Increase public engagement
- Increase the amount of time visitors spend with an artefact
- To provide visitors with detailed information about an artefact or exhibition
- To facilitate social interaction and create a space for discussion

In discussing CH and DT it has to be acknowledged that there are many different types of CH institutions (art museum, natural history museum ethnographic museums, university museums, children's museums, science museums etc.) there are also many different CH institutions that are not confined inside walls such as historic gardens and parks and tourist heritage sites. Furthermore, "there is no "typical visitor" of a "typical exhibition" in a "typical museum" (Mayr and Wessell 2007:2). This heterogeneous nature of the CH sector highlights the need for different approaches to the development and implementation of digital technologies: some museums have dedicated digital departments whereas others may buy in services as and when needed. The important point is that any development in DT has to reflect the CH institution's digital strategy and purpose and to cater for a new and evolving digital audience.

In the last two decades DT has become pervasive and ubiquitous in all aspects of social life and have influenced how we communicate, and network. With the development of Web 2.0 technologies in the first decade of the twenty-first century, which allowed for interactions and social networking, 'community' no longer refers to groups of people who live close together but rather communities can be online global communities who network through the internet and social media. A digitally literate audience expects access to a wide range of CH information and the same experience in a CH institution as in other aspects of their life. DT allows them to have a CH experience beyond the CH institutions walls, before and after their visit as well as during it including those who have never had the opportunity to visit one. To enhance public engagement McKinley and Damala (2013) contend that,

> *The exhibition experience needs to start before the public has left their homes. The navigation of the exhibition becomes an interactive electronic experience, physical spaces endowed with the connectivity and interactive potential of virtual phenomena such as AR, with the aim to announce a new way to experience the public realm through an innovative digital portal* (McKinley and Damala 2013).

Most museums have their own website and visitors can access it from home through a range of devices such as home computer, laptop, smartphone or tablet.

They can:

- plan their visit
- have a virtual tour of the museum or a tour of the current exhibition
- view past exhibitions
- listen to a podcast
- identify the artworks they are most interested in before visiting
- view artworks which may be new to them

The Rijksmuseum in Amsterdam has developed a free multi-media tour app that allows the visitor to access information before, during and after a visit. Based on a concept of 'see more' visitors can browse the museum's collections according to their own tastes or they can have a guided tour of specific masterpieces in the collection. Their website states, "With the Rijksmuseum app your smartphone is transformed into a magnifying glass, a set of binoculars, a time machine, an infrared scanner, a sketch pad, or a magic wand".[53] The app includes a game 'Family Quest' aimed at children 6 to 12 years in which they are introduced to objects and given different tasks to undertake to reveal the secret stories of the objects. The app can be downloaded prior to visiting and as well as finding out information on directions and planning a visit it states, "Seven different routes lead visitors past the highlights, the Golden Age and through the building. The 'magic window' lets you look at the objects through different eyes".[54]

4.2 The Internet of Things, CH and Participation

> *The Internet of Things is an umbrella term used to describe a next step in the evolution of the internet: to augmented "smart" objects, accessible to human beings and each other over network connections ….Underpinning the Internet of Things is the proliferation of networked devices in everyday use, including laptops, smartphones, smart meters and so on. Their number is set to increase worldwide from the current 4.5bn to 50bn by 2050 and could even include personal implants.*
> (McKeown 2014).

With new museum strategies and goals to make collections more accessible and to engage and enhance visitor experience DT has become an intrinsic part of CH from digitised collections, archives and social media to the use of games (gamification) to communicate culture to the use of wearable technologies. Social media has become part of CH practice and has contributed to user engagement and participation, resulting in a shift in which the CH visitor has control. Russo et al. comment that, "The ability of an individual or a community to create, upload, and share digital cultural content demonstrates a proven and growing demand for creative expression, the exploration of identity, and cultural participation using social media" (Russo et al 2008: 7).

The next generation of DT, termed the Internet of Things (IoT) includes 'smart technology' in which smart applications can wirelessly communicate between themselves, objects and buildings,

[53] https://www.rijksmuseum.nl/en/guided-tours/multimediatour[accessed 27/07/2015].
[54] https://www.rijksmuseum.nl/en/guided-tours/multimediatour[accessed 27/07/2015].

> *The basic idea of this concept is the pervasive presence around us of a variety of things or objects – such as Radio-Frequency IDentification (RFID) tags, sensors, actuators, mobile phones, etc. – which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbours to reach common goals.*[55]

With the advent of the Internet of Things, it is not only people who can be connected anytime, anywhere but also anything can be connected[56],

> *We are now moving forward from user-generated content to 'thing-generated content', where objects all around us effectively create and store data about themselves. The trend is increasingly for information linked to and drawn from places and objects with ever greater richness and accuracy* (Srivastava 2011).

According to Lara Srivastava (2011) the Internet of Things is the interlinking of systems that were previously isolated such as objects and data. She summarizes the Internet of Things as:

- Embedded Intelligence ('smart' cities, objects)
- Real Time Monitoring (environmental management)
- Augmented Reality (real/virtual seamlessness)
- Semantic Information (Web 3.0 meets the Internet of Things)

This technology enables present and future generations to add their own perspectives and personal knowledge to objects across space and time in a borderless sharing of knowledge.

In the CH sector, emergent practices include **'**pervasive' media technology which is ubiquitous, in that it is permanently all around and information can be accessed anytime, anywhere from a mobile device such as a phone or tablet, based on sensors that are responsive to locations and emotions and can access content that is sensitive to the situation of the user,

> *Pervasive Media is basically any experience that uses sensors and/or mobile/wireless networks to bring you content (film, music, images, a game…) that's sensitive to your situation – which could be where you are, how you feel, or who you are with.*[57]

[55] *JPI Cultural Heritage and Global Change: Report on Drivers of Change and the Future of Cultural Heritage*: A Review to support the development of the Strategic Research Agenda (2014:4).
[56] The effects and impact of DT on the individual and society have yet to be fully researched and understood. The deliverable acknowledges that it is problematic and not straightforward.

[57] http://www.pmstudio.co.uk/pmstudio/what-pervasive-media [accessed 03/08/2015].

Emergent technologies are also 'immersive' in that they blur the line between the real physical world and the virtual world, creating an experience of being 'immersed', for example, augmented reality. DTs, as communicative technologies, allow for and enable the changes in CH institutions by enabling participation, dialogue and the potential to become more inclusive and democratic.

In the twenty-first century CH institutions such as museums, once considered 'mausoleums', have undergone shift from being authoritative 'gatekeepers' of Europe's CH to a more socially engaged and participatory institution evidenced by the proliferation of public engagement programmes, community programmes and educational activities. In the last two decades the museum has shifted from being a knowledge institution to being a more reflective one. New CH practices include,

- Collaboration with other CH institutions
- Collaboration with their audience
- Promoting public engagement
- Enhancing the visitor experience

The changes in technology are rapid, continuous and ongoing and CH institutions, in order to keep pace with new and emerging technologies, have to be dynamic and creative in their future planning – inventive, creative and open to new ideas.

According to Simon (2010), DT can foster participation and democratisation in CH institutions. One of the most important principles of participation is "dialogue or creative expression, shared learning or co-creative work" (Simon 2010: 1) and one of the ways in which this has been achieved is through the adoption and implementation of DT in accessing, communicating and disseminating Europe's CH. Participation can therefore be considered as central to the aims of this deliverable but it extends this definition to include dialogue and shared learning between CH institutions and research institutions as well as between CH institutions and their audience. CH institutions as social institutions are now considered to be more democratic in being open and transparent in sharing knowledge, networking and developing co-creation activities to be more inclusive and to enable audiences to participate. The increasing use of DT has enabled these changes, however it is important to recognise that participatory technologies are not necessarily digital devices. DT can offer additional and new ways to engage users but basic hands-on activities with tools such as knitting needles or carpentry tools can foster participation and engagement and "the way technologies are used are far more important" (Runnel and Pruulmann-Vengerfeldt 2014: 1).

The growth of Web 2.0 social web technologies since 2000 and the burgeoning use of digital technologies in the CH sector, has transformed participation from "something limited and infrequent to something possible anytime, for anyone, anywhere" (Simon 2010: http://www.participatorymuseum.org/chapter1/). According to Nina Simon, in a participatory culture visitors expect to:

- access to a broad spectrum of information sources and cultural perspectives
- actively engage as cultural participants
- the ability to respond and be taken seriously
- the ability to be able to discuss, share and remix what they consume

(Simon 2010: ii – iii).

Innovative developments in DT and the social Web have enabled participation in the CH sector and, "when people can actively participate with cultural institutions, those places become central to cultural and community life" (Simon 2010: ii).[58] In her book *The Participatory Museum*, Simon describes participatory practice:

> *I define a participatory cultural institution as a place where visitors can create, share, connect with each other around content. Create means that visitors contribute their own ideas, objects, and creative expression to the institution and to each other. Share means that people discuss, take home, remix, and redistribute both what they see and what they make during their visit. Connect means that visitors socialize with other people – staff and visitors – who share their particular interests. Around content means that visitors' conversations and creations focus on the evidence, objects and ideas most important to the institution in question (Simon 2010: iii).*

The social web has also allowed for collaboration and sharing of knowledge, "with the web has come a new collaborative approach to knowledge generation and sharing, a recognition of multiple perspectives, and an expectation by users that they will be able to contribute and adapt/manipulate content to meet their own needs" (Black 2011: 6).

The CH sector, in embracing new and emerging DT, has changed significantly to remain relevant to an ever evolving social audience,

> *Digital projects that lead to participation, immersion, experience and sociality have become currency in a cultural-professional landscape that has become more challenging still since the global economic downturn in 2008. Digital media interventions have been seen – rightly or wrongly – as vital in*

[58] This, however comes with the caveat that not all sectors of society are digitally literate and that they may be 'digitally disenfranchised' by digital technology and may not have access to it.

> *the race to 'prove' public worth, impact, accountability and relevance … thus the power and potentials that technologies have been inscribed with for the museum have been multiple (Kidd, 2014: 2).*

The introduction of participatory practices and DT have resulted in increased accessibility to Europe's CH and the decentralising of knowledge about CH. Visitors can bring their own stories to objects and have the opportunity to contribute to the interpretation of objects and to contribute to the object's history in what has been described as "a form of community intelligence" (Russo et all 2008: 21-22).

4.3 Collaborations: CH Institutions and Academic Research Institutions

New CH practices include collaboration with external agencies such as academic research institutions allow for the sharing of expertise and ideas and the creation of new concepts, practices and knowledge(s). CH institutions have always had to interact with and involve other people whether internal or external to the organisation. Macdonald and Basu contend that,

> *All exhibitions entail the bringing together of unlikely assemblages of people, things, ideas, texts, spaces, and different media. Curators, designers, artists, anthropologists, sponsors, visitors, artworks, artefacts, antiquities, machines, installations, display cases, spotlights, photographs, moving images, catalogues, promotional material, object labels, audio tours, gallery guides* (Macdonald and Basu 2007: 9).

This deliverable, however, is concerned with working in a specific type of partnership, that of the academic research institution in the collaborative design and development of experimental and innovative DT.

Public impact and engagement has become a strategic priority for research institutions in recent years. Many academic research institutions work collaboratively with other departments on interdisciplinary research projects and DT are used regularly. Many universities actively promote partnerships and collaboration through 'Knowledge Transfer' or 'Knowledge Exchange' departments. A definition of this could be that: "Knowledge exchange is the process by which ideas, skills and knowledge move between the knowledge source to the users or recipients of that knowledge and flow back again".[59]

[59] http://www.ncl.ac.uk/business/knowledge/ [accessed 04/09/2015].

For example, The 'Creative Exchange' at Newcastle University, along with Lancaster University and the Royal College of Art in the UK, hosted a Knowledge Exchange conference 'Academic Engagement with the Creative Sector' in 2013 which aimed to propagate new mutually beneficial exchanges between academia and the creative industries and for academics to develop new understandings of the creative sector, "There is a long tradition of academics working with businesses and other partners in the creative sector. As we become more connected, information and collaborations (enabled by new technology and business practice) further promote this fruitful exchange".[60] The conference focused on:

- New and innovative forms of academic collaboration with creative sector partners
- New processes, tools or approaches that facilitate knowledge exchange and collaboration
- Members of the creative commercial sector who are interested in moving into academia and starting to undertake research[61]

According to Victoria Mcguiness, Business Manager for TORCH, The Oxford Research Centre in the Humanities, "since the 1970s, Oxford University has played a major national and international role in the development and use of digital tools and resources for research in the humanities and the University has received more grants than any other university from the Arts and Humanities Research Council for projects with digital research outputs" (Mcguinness 2011).

This demonstrates the proactive approach of research academies in being open to collaboration with external agencies in order to enable their research to have an impact on society. Collaborative working and partnerships can be beneficial for all. In discussing a collaborative project with Bristol Museum, UK, Darren Roberts, Research Collaborator, University of Bristol stated "The research and development can be a way of changing the shape and nature of a place to suit the society that it's a part of" (Roberts 2015).

Research in academic institutions is often funded by public-bodies and many of these have requirements for the research to be collaborative and to have an impact on society. For example the Digital R&D Fund for the Arts in the UK, require project teams to have three partners from three disciplines: an arts partner, a research partner and technology partner. The benefits of this type of collaboration was described by a project partner,

[60] http://thecreativeexchange.org/The-KE-Conference
[61] http://thecreativeexchange.org/tkex [accessed 03/07/2015].

> *This interdisciplinary trinity forms a super-stable foundation on which to work; the Museum provided the requirements, context and content, the University provided the objective framework, and we provided the means, management and distillation of everyone's ideas. Although of course in reality these distinctions blur a lot…* (Chilcott 2015).

Although there are many diverse CH institutions and research institutions, they are not necessarily mutually exclusive. For example ZKM in Germany consists of two museums, three research institutes as well as a media centre; it operates on the interface of art and science, actively encourages cutting-edge insights in media technologies and aims to innovate and develop digital technologies.[62] As stated on its website,

> *As a cultural institution, the Centre for Art and Media (ZKM) in Karlsruhe holds a unique position in the world. It responds to the rapid developments in information technology and today's changing social structures. Its work combines production and research, exhibitions and events, coordination and documentation.*[63]

To demonstrate its commitment to innovation, ZKM also organises the annual ZKM APPARTAWARDS, which rewards innovation in creative art and technology. University museums are another example of the relationship between a CH institution and a research institution where collaboration is an intrinsic part of the process and where curators are also researchers and lecturers and where collections are used for research and teaching.

Any collaboration and partnership has to be carefully managed to be successful but there can be benefits for all partners providing the right partners are chosen,

> *Academic partners can also help you to develop relationships with different audiences and to disseminate your work widely. Ensure you have a frank conversation with your potential university partner before you get started. This will help you get to know each other's audiences, pressures, operating environments and expectations* (Fyfe 2014)

Any form of innovation and experimentation requires time, preparation and an equal relationship between the relevant partners and the most important aspect of this is that no-one in the partnership puts their autonomy first rather, "everyone submits to the risks and interests of *heteronomy*" (Weibel and Latour 2007: 95).

[62] The museums are: ZKM | Media Museum and the ZKM | Museum of Contemporary Art; The institutes for Research and Production: ZKM | Institute for Visual Media, the ZKM | Institute for Music and Acoustics and the ZKM | Institute for Media, Education, and Economics. The Event spaces: ZKM Media Theater, ZKM Lecture Hall and ZKM Cube.
[63] http://on1.zkm.de/zkm/e/about [accessed 10/07/2015].

The following section of this chapter is an overview of best practice in experimental and innovative projects and although this deliverable is concerned with collaborations between CH institutions and research institutions, it is not just about developing experimental and innovative technology – sometimes it also involves the evaluation or the impact of those technologies – skills the researchers may have but which the CH professional may not.

4.4 Best practice in CH: From wild ideas to prototypes

Smartphones

Since 2010 the rise in the use of smartphones has been exponential. For example, in 2014, it was reported that 61% of adults in the UK have a smartphone and Apple announced that they had their 50 billionth download globally (Mitchell 2015).

According to online magazine, eMarketer, "Just under one-quarter of the world's total population will use smartphones this year—and by 2017, more than one-third of all people around the globe will be smartphone users."[64]

In order to remain relevant to a contemporary audience, the CH sector has to keep pace with developments in DT and to cater for a digital audience who expects a digital experience as in other areas of their life,

> *Mobile has had a seismic effect on how people consume content and at their heart, arts organisations are content organisations, so if mobile is fundamentally shifting how people consume content then it is fundamentally shifting the relationship that arts organisations have with their visitors and communities* (Grinstead 2015).

The practice of visitors using their own phone or tablet, having access to Wi-Fi and downloading a free application has led to 'bring your own device' (BYOD) where the CH institution does not have to buy expensive hardware to access the technology as it already exists. In 2014, NESTA, UK reported that, "arts and cultural organisations are responding to the wider shift in media consumption away from desktops and towards mobile devices. Whereas in 2013, a third (33%) of organisations had a web presence optimised for mobile, in 2014 this number has increased to just over half (55%)" (NESTA Report 2014).

[64] See more at: http://www.emarketer.com/Article/Worldwide-Smartphone-Usage-Grow-25-2014/1010920#sthash.ok1Qmtxs.dpuf

Personal mobile devices can be used in innovative ways for visitors to engage with museum objects and apps can be designed for single or group interaction. They can assist in learning in the museum, for example, at the British Museum, London, children can use mobile devices to film and create their own news report in the galleries, inspired by Museum objects. This has influenced the development of new technologies to work with a mobile device such as a phone or tablet which has embedded technology, is Bluetooth enabled, and has a Geographic Positioning System (GPS) which allows for locative technology, Near Field Communication (NFC), QR (Quick Response code) and to enable Augmented Reality. Through the use of mobile technology, CH institutions can be experimental and innovative in developing DT, "the mobile aspect is really key - it's giving the users things to do once they get there, adding a layer fun, adding a layer of interaction and experience that they wouldn't usually get" (Roberts 2015).

Smartphones, however, do not just enhance the visitor experience but can be a useful tool for the CH institution when undertaking visitor studies,

> *Visitor studies explore human experiences within museums, cultural heritage sites, and other informal learning settings to inform decisions. Smartphones offer novel opportunities for extending the depth and breadth of visitor studies while considerably reducing their cost and their demands on specialist human resources. By enabling the collection of significantly higher volumes of data, they also make possible the application of advanced machine-learning and visualization techniques, potentially leading to the discovery of new patterns and behaviors that cannot be captured by simple descriptive statistics* (Moussouri and Roussos 2015).

This information can be beneficial to the CH institution in a variety of ways and can inform:

- Design and layout of future exhibitions
- Understand audience behaviour
- Creation of a virtual tour
- Identifying popular or favourite objects
- The time spent at individual exhibits

QRator

An innovative way in which mobile technology was developed for visitors to experience the narrative in museum objects and galleries is demonstrated through QRator, a collaborative project between University College London Centre for Digital Humanities (UCLDH), UCL Centre for Advanced Spatial Analysis (CASA), UCL Museums and Collections, and the Public Engagement Unit (2011). It

> *explores how handheld mobile devices and new internet-enabled interactive digital labels can create new models for public engagement, personal meaning-making and the construction of narrative opportunities inside museum spaces and aimed to develop new kinds of content, co-curated by the public, museum curators and academic researchers, to enhance museum interpretation, community engagement and establish new connections to museum exhibit content* (Gray et al.2012).[65]

Funded by UCL's Beacons for Public Engagement programme, ten iPads were made available in the Grant Museum, London and each one had a question that visitors respond to either using the iPad itself or via Twitter or the Tales of Things app on their smartphone. The project is participatory and engaging in that visitors can actively create their own interpretations of CH artefacts. Using an iPad or iPhone visitors could type in their interpretations or thoughts about an object. This information then becomes part of the history of the object. The visitor's comments were available for other visitors to read via an interactive display next to the exhibit. In aiming to make the museum visit a more interactive experience,

> *QRator takes the technology a step further bringing the opportunity to move the discussion of objects direct to the museum label and onto a digital collaborative interpretation label, users' mobile phones, and online allowing the creation of a sustainable, world-leading model for two-way public interaction in museum spaces.*[66]

The project was based around the cultural phenomena known as 'The Internet of Things' where computing becomes ubiquitous and everyone and every device is always connected to the internet. The technology was developed at the Centre for Advanced Spatial Analysis, UCL and is an extension of the *Tales of Things* project.[67] An evaluation of the project revealed that visitors were/are inspired to share their experiences and thus co-construct a public multiple interpretation of the objects. This positive outcome achieved the project's aims and objectives.[68]

[65] See Gray et al.(2012) for a detailed account of the project.
[66] http://www.qrator.org/about-the-project/what-is-qrator/ [accessed 04/09/2015].
[67] The *Tales of Things Project* (http://www.talesofthings.com) was a collaboration between Brunel University, Edinburgh University, University of Dundee, University of Salford and UCL. It was funded by the Research Council's UK Digital Economy Program and allows users to attach their memories and stories to any object and share them with other users.
[68] The QRator project was awarded the 2013 Museum and Heritage Award for Excellence, Innovations: Visitor Participation through Social Interpretation.

Talking Statues

The Research Centre for Museums and Galleries (RCMG) is based in the School of Museum Studies, University of Leicester, and is unique in that the research undertaken is intrinsically and directly related to all aspects of CH. The *Talking Statues* project was launched in 2014 for the duration of one year and was funded by NESTA's Digital R&D Fund for the Arts, the AHRC and Arts Council England (ACE) through their National Lottery Fund. The aim was to bring thirty-five statues to life in London and Manchester and some of the UK's celebrated writers were commissioned to write the monologues to animate each statue. Performances were by famous TV and film actors for example, the TV presenter Jeremy Paxton as the statue of John Wilkes defending free speech in Fetter Lane, the actress Prunella Scales as Queen Victoria in Manchester's Piccadilly Gardens, and the actor Tom Conti as Lincoln in Manchester's Lincoln Square. Each statue had a plaque with embedded technology and visitors could use their phone's embedded Near Field Communication (NFC) or QR technology without having to download anything to their phone beforehand, which made it spontaneous. When they swiped the plaque with their smartphone they received a phone call to listen to the statue.[69]

Visitors to CH institutions usually spend very little time in front of an artwork and by animating the statues people were inspired to spend more time and to learn about them. According to the University of Leicester, the project was to assess how CH institutions could use emerging DT such as Near Field Communication (NFC) technology in novel and innovative ways to "overcome barriers to culture and the arts by animating public spaces and forging new cultural links to engage new and non-traditional audiences, including younger and disabled audiences".[70] This would also enhance the user experience and fulfil their mission of improving user engagement. The project was a partnership between University of Leicester research staff at RCMG, Sing London a non-profit event company (http://www.singlondon.org/) and Antenna International (technology) who aims to connect the world to culture through technology (http://www.antennainternational.com).

Research staff at the Leicester School of Museum Studies monitored the project to assess if the technology could lead people to visit museums and to spend more quality time in front of an artwork. As explained in the university report on the project, "The model of using NFC in *Talking Statues* also offers museums and cultural organisations cost effective and imaginative opportunities to develop novel interpretations for their collections and create new pathways to other cultural experiences" (Dodd et al. 2015).

[69] The Talking Statues Project is also discussed in RICHES D5.2 *Place Making, Promotion and Commodification of CH Resources.*

[70] http://www2.le.ac.uk/departments/museumstudies/rcmg/projects/talking-statues [accessed 29/08/2015].

It was one of 24 projects that together received £7 million over the period 2012-2015 as part of the Digital R&D Fund for the Arts.

CATCHPlus

CATCHPlus is an extension of CATCH (Continuous Access to Cultural Heritage), a research project organised by the Netherlands Organization for Scientific Research (N.W.O.) in 2004 in which computer scientists collaborated with the CH sector to develop software for collection management the aim of which was to encourage collaboration, innovation and the transfer of knowledge.

CATCHPlus was the ongoing programme (2009-2012) with the cooperation and collaboration between nine heritage institutions and two academic institutions. It was funded by the Interdepartmental Programme Implementation ICT Agenda (PRIMA), the Ministry of Education, Culture and Science (OCW) and the Netherlands Organization for Scientific Research (N.W.O.). It builds on the initial software and prototypes initiated in CATCH to develop them into reliable tools that can be used in multiple institutions, "from prototype to reliable application".[71]

Building on the partnerships developed in CATCH, CATCHPlus works with CH institutions, universities and private companies to develop software that optimizes searching and navigating CH data to produce a complete digital collection of the CH of the Netherlands and to provide coherency and cooperation to strengthen the digital infrastructure for the CH sector. Eleven heritage institutions were involved in CATCHPlus: Amsterdam Museum, Rijksmuseum, Meertens Institute, Naturalis Biodiviersity Center, Gemeentemuseum Den Haag, National Library of the Netherlands, National Archives of the Netherlands, Netherlands Institute for Sound and Vision, Cultural Heritage Agency of the Netherlands, Netherlands Theatre Institute, Municipal Archive of Rotterdam. Six knowledge institutions were also involved: DEN Foundation, University of Groningen, University of Amsterdam, VU University Amsterdam, Tilburg University, and University of Twente. Some themes of the project include:

- interoperability of large-scale and distributed sources
- visualisation and simulation
- historical dimensions and modern interpretations

[71] http://www.nwo.nl/en/researchresults/programmes/Continuous+Access+To+Cultural+Heritage+(CATCH) A PDF can be downloaded at: http://www.catchplus.nl/wpcontent/uploads/2013/01/CATCHPLusNL-SITE.pdf [accessed 13/07/2015].

Examples of projects include:

- a profile generator with which a museum visitor learns to recognise his/her tastes in relation to the collection and then uses that profile to receive personalised tours and services
- automatic keyword suggestions to support documentation specialists when describing audio-visual materials
- making audio archives searchable using speech recognition
- analysing archaeological discoveries using automatic image recognition and comparison

Examples of their projects include the application *ZieOok* in which visitors to the Rijksmuseum could receive personal recommendations using semantic techniques. For example, if they are interested in a particular painting it can give the visitor suggestions for other items in the collection informed by their personal profile based on the User Profile Repository (UPR) which contains objects the visitor is interested in or stored as their favourites. The CH institution can also assess which images in the collection are visited and how they are rated. In the future, this linked data could include collections from different institutions.

Another project, WITCHCRAFTplus **(**What Is Topical in Cultural Heritage: Content-based Retrieval Among Folksong Tunes) a search engine was developed that made it possible to identify an unknown melody or different variants of melody of the same song among thousands of other melodies. Although databases of songs as 'immaterial heritage' were already in existence they did not allow for the musical content of the song to be searched.

One of the advantages of the CATCHPlus project was the collaboration, networking and partnerships between the IT sector, universities and the CH sector. Each gained invaluable knowledge about how the other sectors work and gained knowledge outside their own discipline and "sometimes institutions even modified their organisation, once they became aware of the new opportunities (CATCH PDF 2012: 13).

SCULPTEUR

In 2002-2005, the SCULPTEUR (Semantic and content-based multimedia exploitation for European benefit**) (**http://www.sculpteurweb.org/) was a three year project funded by the Fifth Framework Programme of the European Community under grant IST-2001-35372. SCULPTEUR developed 3-D visualisation technologies to increase access to CH through extending the browsing, retrieval and navigation facilities in digitised archives.

It was a EU/IST funded collaborative project between five major European galleries: the Uffizi in Florence, the National Gallery and the Victoria and Albert Museum in London, the Musee de Cherbourg and the Centre de Recherché et de Restauration des Musees de France (C2RMF) which is the Louvre related art restoration centre. It also involves the University of Southampton and technical partners Centrica in Italy and ENST in Paris. These CH institutions have extensive digitised collections that were mainly limited to text and 2D images. The aim of SCULPTEUR was to develop multi-media 3D visualisations or models of artefacts, and videos of artefacts and museum galleries, for the "enhancement of facilities for exposing, searching and sharing the knowledge implicit in these collections".[72]

This was achieved through the use of sematic web technologies to link together metadata in museum collections. This allowed for an expanded and more detailed search through shape, 3D form, colour and texture of an artefact or to search for the artist, sculpture or place and the relationship between other artefacts in a similar class. For example a user might search for religious paintings in the Uffizi Gallery that used a particular shade of blue and the semantic technology would retrieve all images that use this colour from a particular period.

Touching the Untouchable

3D printing was developed in the early 1980s and has been used in many sectors of society and is increasingly being used in the CH sector.[73]

Many digitised collections focus on 2-D artefacts but the potential of 3-D visualisations is increasingly being recognised. Consider being able to 'touch' objects in a museum. With the use of technologies such as 3-D modelling which can reproduce accurate replicas the artefacts museums can now advertise 'Please Touch' rather than their usual approach of 'Please do not Touch'. For example the project '*Touching the Past: Adding Touch to the Visitor Experience of Ancient Artefacts'* involved the reproduction of ancient and fragile objects which are too delicate to handle or sometimes even to display. As described by "We are using techniques such as 3D printing and haptic feedback alongside theatre tricks to provide museum visitors with a real sense of touching ancient objects ", Dr Linda Hurcombe, Senior Lecturer in Archaeology at the University of Exeter, UK. The collaboration included specialists from archaeology, academic researchers, CH professionals and computer specialists. The technology allows for an interactive experience where visitors can handle the virtual object. The project was part of a £7.4 million programme of investment through the Science & Heritage Programme that will set the agenda and inform the direction of travel for science and heritage research for the next decade.

[72] For a report on the project see Goodhall et al. (2004). PDF available at: http://eprints.soton.ac.uk/260899/1/EWIMTLongVersion.pdf).
[73] RICHES deliverable 5.1 *The Use of Craft Skills in New Contexts* discusses 3D printing.

The results of the research were presented at the Science & Heritage Programme Conference: Sustaining the Impact of UK Science & Heritage Research, in London on Tuesday 29 October 2013. The project was funded by the Arts and Humanities Research Council/Engineering and Physical Sciences Research Council Science & Heritage Programme.[74]

Museofabber

In 2014, The British Museum worked with *Sketchfab*,[75] an online platform that lets users print and share content online under Creative Commons Licenses. They allowed fourteen artefacts in its collection available to download including a portrait bust of Julius Caesar and a marble bust of Zeus.

Museofabber [76] is a 3D printing company who, since 2013, has focused on the CH sector and aims to promote culture through innovative technology to make culture touchable. They work with European museums, collections and archives to print historical cultural artefacts and assist with the cost, time and training in the use of 3D printing technology. Their emphasis is on education to bring museum objects into the classroom to make them touchable, to be able to handle them and learn about them. The company works with partners from the private sector as well as CH, universities and schools. In February 2014, the Royal Albert Memorial Museum (RAMM) in Exeter, UK collaborated with Exeter Library's FabLab. Using a Makerbot Replicator 5th generation 3D printer, they scanned three Omo Bells, made by the Yoruba of Nigeria in the 19th century and printed a half-sized replica.

3D printing has benefits in that it allows objects to be portable for outreach activities off site. Visitors with visual impairments can have 'touch tours' where they can touch and explore the exhibits and feel the size, scale and texture and enables them to have an enriched and meaningful experience of CH. This can enhance the visitor experience and support the CH institution mission for widening participation and social inclusion.[77]

[74] See more at: http://www.heritageportal.eu/News-Events/Press-Releases/Touching-the-past-Adding-touch-to-the-visitor-experience-of-ancient-artefacts.html#sthash.yBEbo306.dpuf
[75] https://sketchfab.com/britishmuseum.
[76] http://www.museofabber.com/ Museofabber.com is one of the winning ideas of the @Diversity European Idea Competition Awards 2013. The @Diversity Awards were launched by the European Parliament and organised by the Commission's Directorate General for Education and Culture in order to recognise outstanding examples of ICT innovation to promote culture in Europe.
[77] For more information on 3D printing in museums see: http://advisor.museumsandheritage.com/features/in-focus-3d-printing-re-making-the-museum/

The Hidden Museum: Performing museum spaces through digital technology

Many technologies are being developed in the light of the exponential rise in the use of mobile devices. One such technology is the iBeacon which are Bluetooth Low Energy (BLE) transmitters which signals and recognises when a user enters their presence, which is then signalled to a mobile device such as an iPhone or tablet which has Bluetooth to receive the signal. They are a low cost technology and one of the main benefits is that they can transmit outside or inside a building. This is important for CH institutions which may have galleries underground or where large stone sculptures can block a Wi-Fi signal. The potential for the iBeacon in CH sector is enormous and has huge scope,

> *For museums, galleries and public spaces, this is the most important development since the smartphone. It's the missing piece of the puzzle which will change the way mobile devices are used in public spaces, and legitimize their presence in the space, rather than be perceived as a distraction from it* (Stuart 2015).

The aim of the *Hidden Museum* project was to combine iBeacon and tablet technologies to develop a new digital App for Bristol Museum and Art Gallery. This was a one year (2014-2015) collaborative project between Bristol Museum and Art Gallery, Bristol University and Aardman Animations and was funded by the Digital R & D Fund for the Arts. One of the objectives was to encourage people to visit parts of the museum that they wouldn't normally go to and to discover hidden treasures using an iPad as a guide. As described by Zak Mensah,

> *Once the visitor downloads the free app from the Apple app-store they choose their group size, character and how long they have to play. Once chosen they are then presented with their first task. The task will ask them to start by finding the gallery. Once within the space or gallery, which is confirmed via the 100 ibeacons around the building, the challenge is presented. This may be to find a person in a painting or locate an object. Once found they may be asked to take a photo to collect or complete the task. They will then be asked to start the next challenge when ready. They collect each task and then are given a "reward" from the shop. A key aspect of the project was to use the technology to help explore the physical space and promote visiting lesser visited spaces such as the top floors. We chose sculpture, secrets, paintings, stories and parts of the building eg a worn damaged pillar.*[78]

[78] Email from Zak Mensah, Head of Transformations, Bristol Culture, Bristol Museums, Galleries and Archives: 08/09/2015.

Designed as a game, it was aimed at families to make the visit to the museum more fun and playful and to provide effective engagement to promote group interaction and learning. According to Darren Roberts, Research Partner from the University of Bristol, the outcomes of the project achieved these aims. Based on feedback from users, the project team reported that the location-aware technology app has fulfilled its most basic objective,

> *getting visitors to parts of the museum they don't usually go to. The response on this has been virtually unanimous; the app is taking visitors to the less visited parts of the museum, and for the most part they are finding the experience of going to those parts of the museum interesting and valuable.*[79]

iBeacon technology has also been used in the Rubens House in Antwerp Museum where iBeacons have been placed throughout the museum and visitors can discover stories behind the paintings of Peter Paul Rubens through an interactive quiz. Visitors can navigate through the museum using a guided route and the technology allows them to examine a painting in closer detail according to their interest.

Augmented Reality

The shift in museum practice in terms of enhancing the visitor experience as well as the visitor demand in expecting a unique individual cultural experience (Damala and Stojanovic 2012), had led to the use of innovative technologies such as Augmented Reality (AR). As defined by the RICHES Taxonomy,

> *Augmented Reality (AR) is a set of technologies that enhance the perception of reality, by adding overlays of information about the environment and its objects through computer simulation. AR differs from virtual reality: while virtual reality replaces the real world with a simulated one, augmentation is conventionally in real-time and uses real elements from the user's environment with virtual reality overlays.*
>
> *Augmented reality has many applications in the Cultural Heritage domain. For example, it can be used in archaeological sites to provide on-site reconstructions of ancient places, or audio alerts and descriptions of historical places. AR technology can also be used to enrich museum visiting and learning experiences, by adding different content layers or supplying computer-generated simulations.*[80]

[79] Darren Roberts (2015) http://www.labs.bristolmuseums.org.uk/category/hidden-museum/ [accessed 03/09/2015].
[80] RICHES TAXONOMY http://www.digitalmeetsculture.net/projects/riches/virtuality/#a [accessed 04/09/2015].

AR supplements and enhances the information to create an 'augmented' experience and to modify the perception and view of reality and in which the visitor can interact in a seamless world between the real and the virtual. It is based on various computer generated DT such as video, sound, graphics, object recognition, visualising technologies such as holograms and locative technology such as geographic positioning system (GPS) on a mobile device and the user can manipulate the technology to access the virtual information. It is designed to be user-friendly, engaging and interactive and is also immersive in that it blurs the line between the physical and simulated world to create a sense of immersion.

Augmented reality has become popular and widespread in many other sectors such as Information computer technology (ICT), the military, architecture and medicine. One of the first uses of Augmented Reality in the heritage sector was in 2000 in the ARCHEOGUIDE project (Augmented Reality-based Cultural Heritage On-site Guide), an AR guide for archaeology at Greece's Olympia site. As described by the project, "Archeoguide offers personalized augmented reality tours of archaeological sites. It uses outdoor tracking, mobile computing, 3D visualization, and augmented reality techniques to enhance information presentation, reconstruct ruined sites, and simulate ancient life" (Vlahakis et al. 2002: 52).[81]

The initial use of AR coincided with the introduction of mobile multi-media guides in CH institutions, however with the proliferation of smartphones and tablets and user friendly tools created "a new generation of AR-enabled mobile multi-media museum and CH guides" (Damala and Stojanovic 2012: 71). Visitors could now use their own lightweight hand-held mobile device to access and interact with the technology. The initial use of AR in CH institutions can be described in four categories:

- Outdoor guides and explorers
- Interpretive mediation
- New media art and sculpture
- Virtual exhibitions

(Shelly Mannion 2011)

[81] ARCHEOGUIDE was supported by the European Union IST framework (IST 1999-11306) and the European institutions and commercial companies forming the Archeoguide consortium. These include Intracom S.A. Greece, Fraunhofer IGD Germany, ZGDV Germany, CCG Portugal, A&C2000 Italy, Post Reality Greece, and the Hellenic Ministry of Culture.

The History Unwired Project, Venice, Italy

The digital augmentation of places and spaces through use of mobile media technology allows public to access cultural heritage in new and creative ways adding extra dimension to a visit to a CH institution or access to the heritage of a city in what has been termed 'techno tourism'.[82]

The use of AR and mobile technology has been used in creative tourism in cities around the world. For example, in 2004 -2005 researchers at the University IUAV of Venice, Italy and MIT in Cambridge, MA worked with local artists, academics and citizens on the *History Unwired Project*. The aim of this was to produce a walking tour through unknown areas of Venice to reveal its hidden history and bring to life some of the characters using GPS multi-media phones and using video, animation and audio. For example, visitors can access the studio of a Murano glass blower and gain an insight into their character and life and gain knowledge about how the craft is practiced today – information that is not normally available to the visitor.

York City Hologram project

In 2013, the historic city of York in the UK developed a holographic city guide that features historical characters from the city's past such as Richard the Duke of York. Using a smartphone and a free app, visitors can point their phone at a location and the animated characters appear to recount their life experiences, and then the visitor can have their photograph taken with the virtual character. There is free Wi-Fi around the city centre to enable the visitor to access the technology. It was developed for City of York Council and the Yorkshire Air Museum by technology company Appeartome based at York University's science park to bring the city to life.

The Stedelijk Museum, Amsterdam was one of the first museums to experiment with AR. In 2010 it developed the ARtours project to experiment with the latest forms of multimedia technology and AR for smartphones and tablets.

[82] Other projects include: Smart City Museum and Park Arena, City of Genova, Italy which draws on and integrates Future Internet technologies (such as augmented reality services for the appreciation of cultural heritage) with networks of video-cameras used to monitor public spaces. Also see the Or.C.He.S.T.R.A. project (Organization of Cultural Heritage and Tourism for Real-Time Smart Accessibility), based on the development of hi-tech solutions for the intelligent enhancement of cultural heritage is developing, for tourists and residents, a set of technological solutions geared to the enhancement of cultural heritage, both material and immaterial, of the historic centre of Naples in a smart and integrated vision with the goals of sustainability and eco-friendliness (Orchestra Smart Napoli, 2013); The Di.C.E.T. project (Living-Lab for Culture and Technology), will develop its platform of cultural offerings in the city of Lecce, Catania, Agrigento, Siracusa and Centuripe with the aim of creating a renewed cultural perception of the city, both ancient and modern one, of its monuments, ruins, spaces, findings, within museums and beyond, through a combination of knowledge, ICTs and social innovation (Malfitana, 2013); In Calabria, the In.Mo.To. project (INformation & Mobility for Tourism), foresees the development of an innovative platform for the digitization of the tourist and cultural offering in a smart key (Vattano 2014).

An international museum dedicated to modern and contemporary art and design this allowed the museum to present innovative ways of sharing stories about the collection and enter into a new dialogue with the public (http://www.stedelijk.nl/en/artours/history-and-archive#sthash.e9Zck9qp.dpuf) [accessed 30/08/2015].

Trust No One! A Conspiracy Play in King's Kolding (Denmark): The use of gaming to communicate culture.

Trust No One! A Conspiracy Play in King's Kolding is a new type of city walk based on an augmented reality game for tourists using "mixed reality, ubiquitous computing and augmented places as a format for communicating culture" (Sandvik 2012).

The project was a collaboration between Kolding Libraries, Kolding City Archive, VIFIN (knowledge centre for integration, Vejle), University of Copenhagen and VIA University College and addresses the interplay of mobile technology and physical places.

The aim of the project was to communicate the cultural history of the renaissance Danish city of Kolding and rather than have an exhibition, it was done through an augmented reality game to create an interactive and pervasive experience for visitors. Renaissance architecture, streets, statues and monuments, along with actual historical characters to create a narrative story were 'augmented' onto the present day city to bring the past city to life using a mobile phone and web 2.0 services such as location sensitive media, over-layering locations with digital media and augmentation. As described by project partner Kjetil Sanvik of the University of Copenhagen "Digital augmentation of physical places makes us see things in new ways. Buildings are not just buildings, streets are not just streets – they carry stories, they carry cultural meaning which audiences through the interplay between physical locations and the mobile media may acquire, discuss, investigate and relate to in playful and creative ways" (Sandvik 2012). Historical events in the renaissance city of Kolding are mapped onto the present day – creating the past in the present.

MAPTORY

Another project which used AR in the city but in a different way is the project *MAPTORY* (June 2015 to April 2016). The project is organised by the ZKM Centre for Art and Media, Karlsruhe, Germany. Founded in 1989, ZKM consists of two museums, three research institutes, a laboratory and a media centre. It has archives and collections, organises events and exhibitions, and actively encourages practice that is based on participation, discussion and exchange of knowledge. It attracts people from all over the world and from different disciplines such as the arts, sciences, politics and the economy. One of its main priorities is to combine artistic concepts with cutting-edge research into DT at the heart of its practice to ensure relevance for the future. The media practice at KZM includes digital video and 3D animation to interactive installations and environments, from software systems through to the real-time

generation of natural and architectonic environments, and audio-visual applications for performance contexts and augmented reality productions.

> *The ZKM is place of scientific and artistic research. Here, scholars and artists from around the world find unique conditions for realizing their theoretical and practical projects and to present these to a broad public. By way of international collaborative projects with museums, universities and publishers throughout the world, the ZKM is intimately connected with recent developments in the respective fields, and is in a position to itself set the tone by way of introducing themes which are then taken up and received worldwide.*[83]

The *MAPTORY* project uses an augmented reality app on the user's mobile phone to access a map of the city of Karlsruhe with significant historic personalities in art and science, such as Carl Einstein, who perform stories or musical events. The project's website states that, "Facades become interactive painting and games surfaces, whereas posters become cinema screens. With this App, the ZKM attempts to integrate the various genres of fine and performative arts, and transform the city into a novel kind of music theatre" (http://maptory.zkm.de) [accessed 10/07/2015].

Beyond the Visual: Augmented Reality in Spaces of Exhibition

MILES was a project designed to stimulate and foster new interdisciplinary research collaborations across the University of Surrey through a programme of events and funding opportunities. *Beyond the Visual: Augmented Reality in Spaces of Exhibition* (August 2012 – June 2013) was a collaboration between the School of Arts, School of Computing, School of Hospitality and Tourism Management and two external CH institutions: the Watts Gallery in Compton, UK and The Lightbox in Woking, UK which brought together research in science disciplines and the social sciences. The focus of the project was to develop software that addressed the way in which augmented reality could be used in a CH institution to bring to life and enhance visitor experience. The software worked on an android mobile phone or tablet and used an in-built camera and display to provide different information to the user as they walked around the gallery with the aim of creating a multi-sensory experience. For example, by holding up their phone to a painting they may be able to see an underpainting, watch a video or have a detailed narrative about the painting, enriching their understanding and knowledge about it.

There are other benefits for the gallery as the technology allows them to see exactly where the visitor is going, how long they spend at a particular artwork and in which order they view them as the signals from the Wi-Fi act as a form of fingerprinting.

[83] http://zkm.de/en/projects) [accessed 10/07/2015].

This information can have implications for the design and layout of future exhibitions based on visitor preferences and interests, it can inform their communications and interpretation strategy and even how they stock their shop.[84]

Tate: Art Maps

The Tate *Art Maps* project (2012) aims to provide detailed geographical data about the artworks in the Tate's collections in relation to the places, sites, landscapes and environments that informed or led to their geotagging. *Art Maps* consists of a web and mobile app that allow users to explore artworks in the Tate using mobile DT. The project was funded by Horizon, a Research Council United Kingdom (RCUK)-funded Research Institute for Digital Economy Research in collaboration with Tate.

The Tate Galleries in the UK are a significant CH institution and have national collections of British art from the sixteenth century and international art from the twentieth century. Most of the 70,000 artworks have been digitised with general knowledge about the location of the art such as the city, or region. Some artworks were painted in a specific place while others may represent a place, and there may be links to a place such as where the artist had a studio. Working in partnership with the University of Exeter and the University of Nottingham in the UK, they developed a website and mobile application to allow people to relate artworks to places, sites and environments, mainly using their smartphone:

> *By looking at place in relation to artworks, they will become more familiar with both the location and the art, gaining insights into how artworks relate to or differ from the sites they represent, how sites have changed over time, and how sites have been represented and experienced by different artists. Importantly, the new software will enable audiences to explore ideas of location and environment, representation and memory, both on their own and collaboratively in groups (for example, families, friends and schools).*[85]

Users can contribute information about images by responding to a place and uploading their own still or moving images to be published on the Tate's website. This 'crowdsourced' information will assist the Tate in identifying the location of a particular artwork or the viewpoint of the artist, or even the place the materials came from, such as stone from a sculpture and therefore contributing to the history of the artwork. In summary the project aims to:

- develop 'Art Maps' for exploration by place through mobile devices and an associated website;
- invite and capture associative responses to place and space;

[84] The use of visitor data for commercial purposes raises ethical issues that are beyond the scope of the deliverable.
[85] http://www.horizon.ac.uk/Current-Projects/art-maps [accessed 27/08/2015]

- test whether the new software will engage users in new ways with artworks in the collection, particularly the less well known ones;
- explore how mobile technologies can support individual and group learning beyond the gallery;
- develop protocols and processes around the publication of user content on Tate's website;
- test how information about the locations of artworks in Tate's collection may be crowdsourced;
- explore the value of crowdsourced information and associative contributions by the public;
- develop and offer (under open source) a mobile web interface as a tool that can then be used or repurposed by others.

Art Maps can also be used as a guide to a city according to a particular artist's work – for example the artist J.M.W. Turner painted many views of Venice which visitors could visit as they tour the city. A map of the artworks could be made and they could add to it (www.tate.org) [accessed 04/07/2015].

Tatecraft/Minecraft

According to Professor Helle Porsdam, University of Copenhagen, CH will increasingly be popularised by computer games such as *Minecraft* as children become used to interacting with knowledge through such games (Porsdam 2015: 28). *Minecraft* is an online game phenomenon popular with children in which players can build constructions out of textured cubes to create a 3D generated world. It has over one million users worldwide. Adam Clarke of The Common People has translated *Minecraft* into the CH sector with the aim of teaching children about art, artefacts, science and archaeology and to get them interested in visiting museums and galleries. Clark worked in collaboration with the Tate, UK on the project *Tatecraft* in which he was commissioned to explore their collections and choose eight paintings from which to make adventure maps.

In one painting, *The Pool of London* by the Fauve painter Andre Derain (1906), players are able to literally enter the work of art and explore the streets such as the places that inspired the painting, historical landmarks, the stories about it, *The Fauves* use of the colours and the type of paint, the boat, the captain, the customs house and trading permits, all enhancing their knowledge about the painting and the social world in which it was created. Objects can be recreated by 3D printing bringing the virtual creations to life and making learning an interactive, novel and enjoyable experience.

Challenges

As well as having many advantages, experimental and innovative DT can also have constraints and limitations. In 2013 NESTA, UK reported that in England, of 891 arts and cultural organisations surveyed, there were great disparities between institutions when it came to their use of, and perspective on, digital media. One notable finding was that "60 per cent of arts and cultural organisations report that they are primarily constrained in their digital activities by a lack of staff time and funding, and over 40 per cent report a lack of key technical skills such as data management" (Bakhshi et al. Nesta Report 2013: 5).

Practical Constraints

There are also practical issues to take into consideration. Although most applications are free to download some are only available to use on an iPad or iPhone. For those who do not have these devices, the CH institution sometimes have them available for loan but may have to be booked in advance. For example, the ZKM project application is free to download and can be used on an iPad or iPhone and there are up to ten iPads that can be loaned via registration for guided tours on presentation of an identity card/passport. For this, reservations have to be made at least three days in advance by telephone. This, however, also comes with the caveat that unforeseen technical problems with the App or iPads may arise, so loans may be cancelled at short notice.

According to Shelley Mannion, Digital Learning Programmes Manager, The British Museum, Challenges to using location based AR (internal) include:

- Weak 3G reception
- Some galleries are in basement so there is no signal for Wi-Fi
- Very large stone sculptures or objects can block the signal
- The cost of Wi-Fi is prohibitive

(Mannion 2011)

In addition overseas visitors may be reluctant to use their device due to high roaming costs.

Issues to consider in the design of DT

Simon (2010) emphasises that any DT that claims to have participatory elements must be well designed to be useful. In the development of DT, it is essential to design it from a user perspective, placing the user at the centre of the design process and this should be followed up by comprehensive user testing. For example, in the *Talking Statues* project, there were some challenges to negotiating the technology used and the project could have benefited from additional user testing prior to the launch.

Members of the public were unfamiliar with the symbols for NFC and QR that appeared on the plaque at each statue, and would have appreciated greater support or guidance on how to access the audio recording. Not everyone had a smartphone that is NFC-enabled, or access to free Wi-Fi or the mobile internet (3G, 4G) which is a prerequisite for the project. Despite these challenges,

> *Talking Statues appealed to users of a wide range of ages and backgrounds. However, it did not attract the new and non-traditional audiences to culture, as was the project's intention. More could have been done to proactively engage and attract these audiences, in particular disabled people who were barely represented amongst users (less than 2 percent)* (Dodd et.al. 2015).

In addition to 'user-centred' design, time should be allowed for the evaluation of the DT and its impact on the institution as well as the sustainability for the future. Other issues for the CH institution to consider when implementing DT include:

- Staff training in the use of the new DT
- The device has to be user-friendly and easy to use in a short time
- Visitors may need support in the use of the DT
- Free Wi-Fi as and when needed but this can be expensive
- Facilities are required which offer the opportunity to borrow hand-held mobile devices
- Security systems need to be in place for the return of borrowed devices

The training of staff is a key issue in the successful deployment of new DT in a CH institution as summarised by Jenny Kidd:

> *There are training needs associated with working in such ways with visitors and audiences. Those working at the sharp end of project delivery have to act in a number of roles: as facilitators, experts, institutional representative, technicians and perhaps even. This simultaneity can be intensely challenging, and raises questions about the ethics of participatory work. Training in these areas is paramount, but time for staff development is at a premium* (Kidd 2014: 15).

IPR Copyright issues

The increasing use of new technologies and new practices in museums, the accessibility and opening up of collections and participatory practices such as inviting artists in reinterpreting collections is not without its problems. Indeed, the increased access to collections and to digitised images and practices such as co-creation of CH has raised issues and questions regarding ownership, authorship, and copyright. For example, one of the challenges for the 3D printing company *Museofabber* is the copyright of objects, who owns the 3D data, and under what terms museums are willing to license their content.

Visitors who upload their comments and personal interpretation to an artefact also has its problems. For example the Tate *Art Maps* project asked the question "To what extent are users willing to upload and share their materials under a creative commons licence?"

In a report into collections access and the use of technology in museums, the lack of knowledge and experience in dealing with copyright was highlighted as a concern and considered a barrier to using DT,

> *There are key subject areas which impact on the use of digital technologies, particularly the management of intellectual property, and the evaluation of the use of digital, in which museum practitioners feel they lack the necessary skills and knowledge. This prevents them from embarking on a digital option* (Lomas, Hutcheson and Dawson 2012:13).

Conclusion

This chapter has mapped the different and varied extant best practice in experimental and innovative DT projects developed in collaboration between CH institutions and academic research institutions. Through a range of examples, it has demonstrated the changes in the CH sector and the transformative potential in how CH can be understood, engaged with, altered, communicated and participated in. It has demonstrated that there are many benefits to experimenting in the development of innovative DT and in working in partnership with an academic research institution but it has also highlighted some of the constraints. The projects reflect how CH institutions, as cultural communicators, have shifted from being mono-vocal to multi-vocal (Tatsi in Runnel and Pruulmann 2014) and how the contemporary CH institution can be described as a 'contact zone' (Clifford 1992; Pratt 1994), as a space of encounter for collaboration and sharing of knowledge, for innovation and experimentation in DT and a space for participation, dialogue and interaction. They exemplify that,

> *Today the contemporary museum sector is one in which digital culture is actively collected, where computer-based interpretive media allows exhibitions to support experiences in more flexible, creative and empowering ways, and where institutions are tuning their modes of delivery and audience engagement to the emerging channels of our evolving digital society* (Parry 2009: 2).

The development of the semantic web technologies and the 'Internet of Everything' (IoE) will create further opportunities for CH institutions. Demands for instant access to CH will increase as these new DT emerge, and the increasing use of mobile technology through mobile or wearable devices means that certain sectors of society can be online at any time of any day. CH institutions, as social institutions, will need to continue to adapt, to collaborate and be creative and inventive in their experimentation and adoption of DT. This will mean taking risks, sometimes getting it wrong but learning from mistakes.

> *One of the future opportunities with Museums in the digital age is to enable visitors to have a more personalised experience, rather than a 'fits all' approach to displays. As wider society has an almost unlimited access to information, the expectation of the visitor can often require more from museum displays. Digital applications can create a wider experience and immerse the visitor further with social media, interactive displays and mobile phone applications etc.* (Mcguinness 2011)

Many of the projects in this deliverable are limited within a timeframe, mainly due to the funding that is for a defined period. Some of the projects, however, have emerged out of other projects and some have led to new projects. In terms of learning they have all had an impact in that they have helped to change attitudes and practice both for the CH sector and for the research institution, which have both learned from each other and all projects have contributed to the ongoing and transitional landscape of the cultural sector in a digital age. The projects stimulate the opportunity for the recalibration of relationships between CH and its users. According to Martin Roth, Director of the Victoria and Albert Museum, London, digital developments have been an essential necessity in widening access to the museum's collections. In asking the question 'What does the presence of digital within museums bring?' he suggests that they can:

- Break down hierarchies
- Reach wider and new audiences
- Create new sensory experiences
- Enable online visitors who cannot visit the museums to access collections
- Tell stories of their collections in innovative and interactive ways

(Roth 2011)

The chapter has shown that many CH institutions, however small, are open to partnerships and as demonstrated there was wide-ranging support for collaboration and knowledge sharing. In a report into the use of DT in accessing collections a CH professional, when questioned about working in partnership stated, "Partnerships, joint working, and sharing of knowledge and expertise should be enhanced" (Lomas, Hutcheson and Dawson 2012) which indicates that museum practitioners value the opportunity to share their knowledge and collaborate with others whether within their own museum, with their visitors, or with an external institution.

Collaborations and partnerships are not always straightforward and have to be mutually beneficial for all parties. Specific skills required for collaboration include:

- team-working
- mutual understanding and respect for others' ideas
- sharing knowledge and expertise
- negotiating differences

This deliverable asserts that the important point is that the digital does not reproduce the same knowledge in a digital format, rather it promotes the creation of new knowledge(s). The digital, with emphasis on user engagement, interactivity and participation that involves the user enables them to create their own interpretations and knowledge of CH and to share this with a global audience through social media networks. According to Suzanne Keene, "Museums could, given the will and the resources, become the focus for generating ordered and systematic information about the whole material world" (Keene 1998: 2).

The experimental and innovative projects have demonstrated that:

- DT has become more embedded in CH practice and this has to continually evolve in order for the CH sector to remain relevant for a contemporary digital audience.
- Design and development of DT has to begin from a user perspective and be 'user-centred'
- There is an increasing emphasis on mobile technology
- Changing experience of visiting museums: a more personalised and individual experience
- Innovative experiences include pervasive technologies and immersive experiences
- The CH institution can be a 'contact zone' for exploration and discovery

In terms of CH practice and collaboration in developing experimental and innovative technologies, outcomes include:

- Collaboration can bring different departments within the CH institution together as well as external agencies and an interdisciplinary approach can generate new ideas and perspectives.
- Cultural heritage professionals and academic researchers can work in partnership and collaborate on new technologies to contribute to European citizens in being able to access, communicate and disseminate cultural heritage.
- By adopting and innovating digital technology museums can fulfil their mission in widening participation and inclusion and making their collections more accessible.
- CH material which is kept in the stores of museums due to conservation issues can be replicated with 3D and then made visible and available to the European citizen and has the potential for new interpretation and knowledge.
- The financial costs of technology innovation and implementation in the CH institution can be minimised and shared through partnerships.
- The visitor experience can be enhanced both inside and outside the museum.
- Museum activities can be interactive, educational and fun

As demonstrated throughout this deliverable, the CH sector is experimenting with innovative technology but this is usually done on an individual basis with the DT designed according to the requirements of the institution. One of the key features in the development of DT for the future is 'interoperability' as defined in the RICHES Taxonomy,

> *Interoperability' refers to the shared quality of computers or electronic devices, by which information and data exchange among these devices becomes possible. When interoperability conditions are met, data can be transferred freely from several devices or across platforms, for instance from a desktop computer to an external hard drive or a Compact Disc.*
>
> *The quality of interoperability can be applied as well to societies, communities or global communications. In this context, interoperability can be described as the ability of multiple social, political, and legal entities to work together, cooperate and exchange information (inter-operate) for achieving a common goal.*[86]

[86] RICHES TAXONOMY http://www.digitalmeetsculture.net/projects/riches/virtuality/#a [accessed 04/09/2015].

For future experimentation and innovation in DT in the CH sector, interoperability is essential as it "lowers barriers to innovation and is fundamental to the creation of participation" (Maurizio Pilu, Executive Director for collaborative R&D at Digital Catapult quoted in Kobie 2015).

The importance of the 'best practice' projects mapped in this chapter is to learn from the best of what has come before. The CH institution, as a social institution has to maintain the pace of continuous and evolving DT in order to remain relevant to a digital audience and to attract a new generation of CH visitors. The projects demonstrate that one way this can be achieved is through collaboration with academic research institutions that can support them with funding and with cutting-edge research in DT which places the CH user at the centre of the design process.

Adopting innovative DT and maintaining and attracting new audiences can ensure that the CH sector continues to contribute to Europe's creative economy. These changes in CH practice and working in partnership have recalibrated the relationship between the CH sector, the research institution and the CH visitor, one of the aims of the RICHES project. CH institutions who are creative and open to experimentation and innovation in DT can reach an audience that is constantly connected, anytime, anywhere and can enable the visitor to actively participate. Visitors can create, explore, access, communicate and interpret CH according to their own personal tastes and needs and in their own time and place and this has "put the power of communication, information gathering, and analysis in the hands of the individuals of the world" (Freedman 2000: 299). As Simon (2010) asserts when people are engaged and can actively participate in culture, the CH institution becomes central to cultural and community life.

The next section will focus on two case-studies of collaboration and innovation in DT between CH institutions and research institutions which address the experimental in the research institution and its practical implementation in the digital economy.

5. CASE STUDY 1: ARtSENSE (Augmented RealiTy Supported adaptive and personalized Experience in a museum based oN processing real-time Sensor Events): Adaptive Augmented Reality for CH.

FUNDING: The Seventh Framework Programme of the European Commission FP7 – ICT Call 6 – Project Reference 270318.79

COLLABORATION: 10 Partners in 6 European countries. (5 Technology researchers; 2 industrial partners and 3 CH partners).

> *Museums are not only competing with each other but also with other venues and attractions, while museum visitors become more and more demanding and interested in having a unique and tailored to their needs museum visiting experience. The evolving demands of museum visitors, the opening-up of museums to their public and the chase for an even more personalized museum visiting experience, set a new challenge and led to a new generation of adaptive AR (A2R) guides that should be able to drive this personalization. Within this context our thesis is that the notion and essence of adaptation is the next step in the development of AR systems. (Damala and Stojanovic 2012: 71).*

This case study is based on the ARtSENSE project. It examines the use of augmented reality (AR) in the CH sector and the emerging innovative development of this technology and its potential to provide a tailor-made, personalised adaptive CH experience. This was achieved through the close collaboration of CH institutions, academic researchers and scientific technologists. The case study explores the collaboration and partnership, the rationale for the project, the objectives, aims and methodology. It then discusses the experimental and innovative ARtSENSE technology followed by its implementation in the three project partner CH institutions.

The ARtSENSE Project

A new generation of museum guides is demonstrated in the European research project ARtSENSE (Augmented RealiTy Supported adaptive and personalized Experience in a museum based oN processing real-time Sensor Events). This three-year European-funded project (2011-2014) aimed to bridge the gap between the digital world and the physical world to further enhance the visitor experience of CH.

As described on the European Cordis website, "ARtSENSE tackles a very important problem in the modern usage of ICT in cultural heritage domain: bridging the gap between the digital world with the physical in a highly flexible way in order to enable a novel, adaptive cultural experience". [87]

The ARtSENSE project represents the future of AR to become 'adaptive' to visitor's interests. The emerging technology of Adaptive Augmented Reality (A2R), developed by ARtSENSE, is based on audio, visual and physiological sensors. Based on cutting-edge 'biosense' technology, it is innovative and experimental in that 'adapts' information in 'real-time' in response to the visitors' interests which is monitored through the sensors. The ARtSENSE project has developed non-intrusive wearable technology in the form of a pair of specially designed glasses, which can digitally project a virtual overlay of information on the physical object or image in the wearer's field of vision. Using sensor technology, it tracks the visitor's visual interests in a particular artwork and provides extended information about it to individualise and enhance their experience and to increase their knowledge about it. This enables each visitor to have a personalised experience depending on their interests picked up by the sensors,

> *The visitor is equipped with a pair of AR see-through glasses able to track his or her gaze and eye-movements. The visitor can use natural gestures to interact with the multimedia content delivered to the view through the glasses in the form of virtual overlays. Audio augmentations are also provided, as well as 3D sound effects, while the acoustic and affective attention of the visitor is continuously monitored through the use of audio and acoustic sensors. Thus the visitors have the feeling that physical objects are directly responding to them; the artworks become active artefacts that react on users' attention and engagement levels (McKinley and Damala (2013).*

The Collaborative Partnership

The project was a collaboration of ten European partners and consisted of:

***Five technology researchers*:**

- John Moores University, Liverpool, United Kingdom
- Karlsruhe University, Germany
- Fraunhofer Institute of Optronics, System Technologies and Image Exploitation, Karlsruhe, Germany
- The Polytechnic University of Valencia, Spain
- Ministerio de Educacion, Cultura y Deporte, Spain

[87] http://cordis.europa.eu/project/rcn/97475_en.html [accessed 04/08/2015].

***Two industrial partners*:**

- Corvinno Technologia Transzfer Kozpont Nonprofit Kozhasznu KFT, Hungary;
- CIM GRUPA Doo, Serbia.

***Three CH institutions*:**

- Musée des Arts et Metiers (MAM), Paris, France
- Museo Nacional de Artes Decorativas (MNAD), Madrid, Spain
- The Foundation for Art and Creative Technology Ltd (FACT), Liverpool, United Kingdom[88]

The research was funded by the cooperation programme of the Seventh Framework Programme of the European Commission FP7 – ICT, Call 6 – Project Reference 270318.[89] The initial stages of the project involved the meeting and collaboration of partners including academic researchers, CH professionals and technologists to identify needs and then to develop the technology that would give a personalised, augmented CH experience.

Background and Rationale

Augmented Reality (AR) is the overlay of visual digital augmented information onto a physical artefact or image in the real world to expand and enhance the information about it. It supplements and enriches the experience and knowledge about the visual image or object.

The initial use of AR in the CH sector in early 2000 coincided with the introduction of mobile multi-media in museums. The proliferation of smartphones and easy-to access mobile technologies created a new generation of digitally literate visitors to CH institutions and created the environment for the development of AR-enabled multi-media museum guides. Visitors could now use their own lightweight hand-held mobile device during their CH visit. However, this had limitations in that the augmented information is predefined and fixed so that every visitor has the same experience as the same digital information is overlaid onto the physical image. The small screen surface of the smartphone prevented total immersion as the boundaries between the real and the virtual remained apparent and prevented a seamless experience.

[88] FACT is one of the UK's leading media arts organisation promoting new forms of artistic and social interaction between communities and individuals. FACT receives an average of 350.000 visits per year by encouraging the public to participation and engagement through activities targeting visitors of different ages and backgrounds (Damala and Stojanovic 2012: 75).

[89] Research area: ICT-2009.4.1 Digital Libraries and Digital Preservation. Further information regarding the project can be found at: http://www.cordis.europa.eu/project/rcn/97475_en.html © European Union, 2015.

In addition, AR is based only on visual augmentation of information – the object or visual in the real physical world is supplemented, enhanced or augmented by visual digital information.

Within the context of shifts in CH practice and an emphasis on enhancing the visitor experience, the ARtSENSE project team realised that the future for AR was to make it 'adaptive' to the needs and interests of the visitor to enable them to have a unique, visitor tailored CH experience. This was created through the use of visual, audio and physiological sensors to monitor the visitors' gaze and gestures, acoustic environment and bio-signals. Damala and Stojanovic (2012) suggest that a new generation of CH visitors are digitally literate and demand a unique and personalised CH experience and this led to the development of AR within the CH sector in which AR can be 'adaptive' to visitors' interests and needs or an Adaptive Augmented Reality (A2R). Damala et al. state, "We define A2R as the process of adapting the augmented reality to the current context and personal characteristics of a user of an AR system" (Damala et al. 2012: 750). A2R therefore represents an innovative and experimental development of AR which goes beyond augmenting a CH visit in a visual way, continuously 'adapting' the content according to the visitor's interests to enable a highly individualised and enhanced CH experience.

Objectives

One of the main objectives of ARtSENSE was "to provide a prototype that enables a personalised experience for every individual visitor by adapting to the psychological state of the visitor the content presented through an augmented reality museum guidance system" (Damala et al. 2012: 746). The aim was to improve and enhance the visitor experience by adding deeper levels of information to an artefact depending on the visitor's interest. This was achieved by developing existing AR guides to enable them to be 'adaptive' and responsive to the visitor to create an 'adapted' experience (A2R).

ARtSENSE was based on the idea that visitors to CH institutions are not passive viewers and recipients of information, rather they actively produce their own individual interpretations based on their own background and life experience. According to project partners Damala and Stojanovic, the objectives for the ARtSENSE project were based on David Burrow's phenomenology of sound and human thought, which places the visitor at the centre of the design process. Three objectives were used:

- Centre on the human participant
- Consider the idea of sound as much as the idea of sight
- Acknowledge that human participants move, think and exist simultaneously[90]

[90] Burrow, D. (1990) Sound, Speech and Music: MA. University of Massachusetts Press in Damala and Stojanovic 2012: 72.

Within the context of a CH institution visit, this perspective allowed for the projects motto: “See, hear, feel, sense, experience”:

> *The ARtSENSE visitor does not just see virtual overlays, menus and buttons. The visitor sees, hears and contemplates, interacts with both the virtual and the physical world in a seamless way and experiences feelings and emotions considered as playing an important role in the cognitive and affective impact that eventually constitutes the museum visiting experience. (Damala and Stojanovic 2012: 72).*

In addition to providing visual, audio and video augmentation, one of the most intriguing aspects of A2R is the innovative technology to monitor, capture and process the human affective and cognitive knowledge about the impact of blending the physical and virtual worlds. With this innovative and experimental approach, the ARtSENSE project represents the shift in development from AR to A2R.

Aims

A summary of ARtSENSE aims are as follows:

- To seamlessly blend the physical world with the virtual world
- To create an immersive experience
- To design non-intrusive wearable technology
- To personalise and individualise experience of CH
- To continuously adapt to visitors’ to interests

Methodology

In developing the technology, the ARtSENSE team undertook ethnographic research in the three partner museums. This consisted of:

- Inobtrusive observations of museum visitors to establish how they used existing interpretation material such as text panels and audio guides.
- Participatory observations of guided visits for groups such as schoolchildren or families by museum staff to establish the type of narratives used (whether through storytelling, songs or music).
- Inobtrusive observations of creative workshops to identify how games and edutainment could be used in an A2R context.

Research also consisted of brainstorming sessions, questionnaires, informal and semi-structured interviews, technological experiments and tests. This was important to target the end-user - the CH professionals and the CH visitor - of the A2R who would also evaluate and judge the success of their experience in using it. The design approach was therefore a user-centred design approach (UC).

The design process was iterative and the team of researchers, technology experts and CH professionals worked closely together. Within the collaboration and throughout the design process, the CH partners had to have a thorough understanding of the concept and application of the technology, and the technology partners had to be flexible in adapting and adjusting the technology based on the CH professional's advice on what was acceptable within a CH context. The CH professionals also had to be familiar on how to use the technology as they would ultimately have to tailor it for their own institution and implement it as part of their practice,

> *The CH professionals need to appreciate and work on the potential of the technology, understand how it works, apply the potential of the technology to the design phase, then develop, create but also test and evaluate the learning scenarios and the interpretation material they will be delivering through the AR guide* (Damala and Stojanovic 2012: 74).

It was essential for all the collaborative partners to understand the working practice of the CH institutions as this would be where the technology would be used. Each institution differed and the team needed to know the different departments that make up each institution and who would be responsible for the application of the technology. Tests were carried out in the three CH institutions to identify their needs,

- Visual augmentation
- Gesture interaction experiments to understand how humans interact in a museum environment in an intuitive way
- Experiments with audio spatialisation
- Public demonstrations of multi-media material with real-time biosensor monitoring

ARtSENSE Technology

The innovative ARtSENSE technology is based on visual, audio and physiological sensors. The gaze and gesture control creates an interactive experience so that the visitor feels that the image or object is responding to them and the 'active' artworks 'sense' the users visual attention and emotions and can augment more or less information about them. The CH experience is not just 'augmented' with visual and audio content, but by adapting the content according to the visitor's interests, it offers a highly flexible, adaptable and individualised CH experience.

Visual sensors: visual augmentation and AR glasses

One of the main aims of the ARtSENSE project was to blend the real physical world with the virtual one, and existing technologies such as the smartphone screen prevented this seamless immersion.

The ARtSENSE solution was to design non-intrusive wearable technology to allow for AR and to track the eye-movements of the wearer:

> *One of the main novelties of the ARtSENSE project with regards to the visual augmentation of CH contexts is the use of a light-weight, optical see-through, AR display that can capture the eye-movements, the gaze and the hand gestures of the visitor. The eye-tracking can be used to trigger content while through the gesture interaction the visitor will be able to interact both with the digital and the physical environment in an intuitive way.* (Damala and Stojanovic 2012: 72).

The eye-tracking of the visitor's gaze is important as it is used as an index to calculate the direction and the amount of time and interest on a particular artwork or object in real-time, and the sensors can then 'adapt' to received information about the visitor to augment more or less information. The eye-glasses are fitted with a scene camera which allows for hand gesture-recognition which enables interaction through wiping or pointing.

Acoustic sensors: audio augmentation and acoustic monitoring

The second important component of the ARtSENSE technology includes audio augmentation and acoustic monitoring. Analogue and digital audio guides have long been a feature in CH institutions. The A2R approach does not just deliver audio in combination with what the visitor is looking at but is continuously adaptive,

> *In an A2R environment, the audio surroundings are monitored continuously so that the content is adapted accordingly; if a gallery section is too crowded, the visitor will be guided to another exhibition room, the volume will be adapted accordingly or the surrounding noise will be filtered out, providing an important service and guidance to the visitor* (Damala and Stojanovic 2012: 72).

A2R also includes a 3D audio spatialisation feature, "as the system is aware of the position of the visitor, the artefacts can speak for themselves and address themselves to the visitor" (Damala and Stojanovic 2012: 72).

Biosensors: affective monitoring and physiological sensors

Based on the affect and emotion of the visitor and the interrelation between emotion, cognition and learning, the third and most innovative approach of A2R is monitoring of the "affective impact of the visual and audio augmentations and the interaction of a museum visitor with the physical and digital environment through the use of physiological sensors" (Damala and Stojanovic 2012: 72). The technology allows for the interest and engagement of the augmented visit to be monitored and this can,

> *provide important feedback about the personalization, adaptation and delivery of interpretation and learning materials that best fit not just predefined visitor profiles but the unique aesthetic experience a visitor is immersed in during a cultural visit* (Damala and Stojanovic 2012: 72).

Physiological sensors can provide 'biofeedback' from the body and in the case of ARtSENSE, feedback was provided from the heartbeat, brainwaves and changes in the skin to reveal real-time information about positive or negative emotions towards an exhibit. This determined their level of interest in an exhibit or to see if they have disengaged with it,

> *For example, if the visitor is interested in the artwork he is looking at, more information and more details will be provided by the AR system. On the other hand, if the visitor seems to be lacking interest, other artworks will be suggested and/or different content will be provided taking also under consideration the logs, visiting history, types of content and media that stimulated the visitor's engagement and interest* (Damala et al. 2012: 748).

The Application of A2R in CH Institutions

As previously stated the project tested and evaluated the use of the technology throughout the development process. In particular they focused on the end users: the CH partners in the project and the CH visitor and user. The three CH institutions in the project were very different in terms of size, audience and aspirations and this was a deliberate choice by the project partners to test the different ways in which the new technology could be used. As described by the partners,

> *The collaboration and active participation of not just one but three CH partners was grounded on the hypothesis that the deployment of an adaptive AR guide in three complementary types of museums could promote our understanding of the potential of the A2R approach by encouraging the collaboration among CH professionals while promoting a more extensive coverage of the potential of AR and the A2R approach as an interpretation medium for the museum visit and potentially*

> *other related formal and informal learning environments* (Damala et al. 2012: 747).

To develop technology that could be deployed in innovative ways in different CH institutions with diverse collections was one of the main challenges of the project. Below is a summary of the application of A2R technology in three institutions.

Museo Nacional de Artes Decorativas, Valencia, Spain (MNAD)

The project partners Roger McKinley and Areti Damala describe an example of the use of A2R technology through the augmentation of an eighteenth century tiled kitchen in Valencia, Spain which is displayed in The Museo Nacional de Artes Decorativas (MNAD), one of the project's partners. The tiles make up a visual domestic display consisting of figures, food, kitchen utensils and animals framed by garlands of flowers representing a scene depicting the preparation of a chocolate party. In discussing AR they contend that,

> *There is a large variety of visual and non-visual content that can augment this artefact: from iconographic parallels (costumes, dresses, jewellery, tools and recipients) to cooking recipes or music of the same period, the possibilities seem to be endless. The particularity of the ARtSENSE approach resides in the fact that due to the eye-tracking mechanism the augmented content will appear in relation with the very particular detail a museum visitor may be contemplating (like for example the tray with the sorbets that the servant at the left carries). Each figure and detail has the potential to act as an entry point to a story that is narrated in all four kitchen walls, once it attracts the visitors' visual attention. Animated dialogues among the depicted figures as well as 3D sound effects may also act as entry points for the augmented visit. Throughout the full visit, the bio-sensing equipment monitors the psychophysiological impact of the augmented museum visiting experience in terms of activation, cognition (level of mental effort) and valence (level of positive or negative feelings towards either a physical object or the multimedia content delivered)* (McKinley and Damala 2013).

Testing ARtSENSE at MNAD, Valencia, Spain.
Thanks to ARtSENSE project

The Musée des Arts et Métiers, Paris (MAM)

The Musée des Arts et Métiers, Paris (MAM) is characteristic of the challenges that science and technology museums present in terms of museum education and communication. The "artefact" that was augmented was the laboratory of Antoine Laurent de Lavoisier, featuring the equipment with which Lavoisier realised the experiment of the synthesis of water. This is a difficult exhibit to decode, with many parts of the original equipment used (including the connections among them) missing. As stated by the MAM museum professionals, the main goal here is not only to augment the exhibit with multimedia contents related with the life and work of Lavoisier but also to make the visitors "visualize the instruments, weigh the gases, connect the gas meters to the balloon, create the spark and repeat on their own Lavoisier's experiment" (McKinley and Damala 2013).

FACT: Foundation for Art and Creative Technology Ltd, Liverpool, United Kingdom.

The third CH institution FACT posed a problem in that it is a contemporary art-space that does not have permanent collections and has temporary exhibitions. The idea was to use the building itself as a cultural artefact to be augmented and demonstrated another use of the ARtSENSE technology. Many famous film-makers and creative professionals have visited FACT and this historical and relational association with the building was the focus of their project. One of the structural pillars of the building was used to create 'the VIP Signature Pillar' in which the signatures of some the very important people (VIPs) such as musicians, artists, film-directors such as Quentin Tarantino who had visited FACT and signed in, were augmented onto the pillar. Each signature was supplemented with in-depth information about the person and their work such as film-clips, interviews and soundbites and, "the visitor equipped with the system would be able to get to this rich media content in a novel way and there was enough content to be able to adapt to the users' level of engagement and supply them with appropriate material" (McKinley and Damala 2013).

Augmented VIP pillars at FACT, Liverpool, UK
Thanks to ARtSENSE project
Both ARtSENSE images available at:
http://mw2013.museumsandtheweb.com/paper/artsense-and-manifest-ar-revisiting-museums-in-the-public-realm-through-emerging-art-practices/

The three CH institutions had their own aspirations and initiatives for the project and invited different professional groups and audiences into the design process and according to the project partners this brought "a new breadth as to the varieties of ways through which A2R can alter and shape our everyday environments both in indoor (e.g. the museum) and outdoor operating and learning environments" (McKinley and Damala 2013).

Outcomes

Some of the outcomes of the ARtSENSE project and A2R technology have resulted in the potential for the enhanced experience of CH. For example,

- Objects usually viewed from the front can be viewed in 3D allowing for fuller visual impact
- Some delicate objects have to be kept in dark light due to conservation issues – these can be viewed in more detail
- Artefacts such as furniture might have hidden compartments inaccessible to the public – AR can assist in manipulating these hidden aspects to reveal the 'hidden history' to the visitor.
- Museum objects are often decontextualized from their original context. The original context of an object can be reconstructed to show how it might have been used and by whom.
- Objects and images are tangible aspects of CH. AR can assist in adding intangible aspects such as song and dance thus helping to bring the objects 'alive'.

- Similar objects or images from other museum collections can be viewed alongside an object or image to show similarities and differences of types.

DT has made CH more accessible in many ways and these outcomes demonstrate how emerging innovative technologies such as A2R can make them even more accessible, one of the aims of the RICHES project.

The Adaptive Content

In addition the adaptive content of the A2R technology had added benefits in that it was no longer based on the same predetermined information for all visitors but on the continuous monitoring of the reaction of a visitor towards the exhibition and the content delivered through the A2R guide. The project partners comment that, "The sensors can detect reactions such as excitement and then provide more detail about the object or it can detect boredom and change the content" and this can "make the visit more exciting and rewarding thus promoting intrinsic and self-motivated learning" (Damala and Stojanovic 2012: 77).

- The visual sensors which monitor the gaze of the visitor's interest in an object can provide information to the CH institution about which aspects of the object the visitor is interested in as well as the most popular objects that visitors spend time on.
- The physiological sensors that monitor engagement and interest can give important visitor feedback about how an exhibition has been organised or the level and detail of the interpretation material that can be used for planning future exhibitions.

The CH institutions involved in the project provided feedback, which included the importance of the adaptability of the technology to the visitor's profile in creating a personalised experience. The originality and innovation of the device, which made it stand out as different and novel from anything else the visitor was familiar with was cited by MAM as an element in the success of the project. The immersive experience enabled by the technology was also considered an important aspect as described by the CH professionals at MAM,

> *The more the visitor will live the visit, the more the souvenirs will be strong. Triggering the visitors' imagination and encouraging active involvement in the digital narratives are essential keys. The work of immersion in the content is cognitive and sensory, particularly visual and acoustic* (Damala and Stojanovic 2012: 77).

The adaptive assistance technology is immersive and interactive for the visitor and provides a valuable and personal CH experience and achieved the aims of the ARtSENSE project.

Conclusion

This case study demonstrates that through interdisciplinary collaboration with external agencies, CH institutions can develop innovative, revolutionary technology to enhance and expand their public engagement. It enables them to provide their visitors with a valuable, personal CH experience, to track their emotional preferences, and to expand their interests and capacity to engage with unfamiliar and difficult objects. As described by the ARtSENSE team, "The ARtSENSE device represents a breakthrough in the application of new technologies to CH institutions and creates new communication channels between museum visitors and artworks" (Damala et.al 2012: 755).

The ARtSENSE project was developed within the context of CH institutions evolving practice based on visitors' interests and needs.[91] The case-study demonstrates that CH institutions are receptive and open to experimentation in enhancing the visitor experience and to provide them with a unique personal experience: the aim of the ARtSENSE project. The first use of AR in the CH sector was the first step in creating and providing an innovative experience. However the evolving demands of visitors created the context for further development – to provide a very individual experience – and the development of AR to be 'adaptive' to those demands. Adaptive Augmented Reality (A2R) has allowed for the personalisation of CH and reflects the shift from AR to A2R. However, in order for experimentation and innovation in DT to be sustainable it has to become an intrinsic part of the CH institution's public engagement strategy.

The ARtSENSE project is innovative in enabling an adaptable and personalised CH experience in a novel and experimental way. Any experience of CH is an individual experience in that everyone appreciates and interprets CH according to their preferences and tastes,

> *A journey through an artwork is always an open and personal one and ARtSENSE is about making the invisible visible through a personalized and adaptive journey – exposing the hidden content the museum holds. Artists create culture but the experience of art itself is unique and personal and ARtSENSE is about people's cultural heritage delivered in new ways* (McKinley and Damala 2013).

[91] There was a lack of information on how this was determined.

The team consisted of researchers, technologists and CH practitioners. This case study demonstrated that for an interdisciplinary project to be successful it was essential for the team to work very closely together at all stages of the concept, development process and evaluation of the project.

This entailed being democratic, understanding, sharing knowledge and gaining new knowledge outside of a particular discipline, being flexible, listening to others' points of view and adapting to them. Damala et al (2012) contend that the success of the project was due to the close collaboration of all partners involved as well as the active participation throughout the whole project from beginning to end.

The application of ARtSENSE technology to FACT in Liverpool was challenging as contemporary art galleries do not in general have historic permanent collections of art but rather have temporary rolling exhibitions. The creative and artistic solution was to use the technology to reveal the history and social life of the building itself taking DT and CH in a new direction outside the walls of the institution and creating a new visitor experience of CH.

In developing wearable and non-intrusive technology, the ARtSENSE project revolutionised adaptive assistance. ARtSENSE technology in adaptive augmented reality is the beginning of a new generation in the experience of CH within and beyond the CH institutions walls. It is an example of,

> *Innovation and experimentation in the digital economy … and how the ways in which we understand our CH, how we engage with it, alter it, how we communicate and participate in it, can be transformed through the use of digital technologies* (RICHES DoW Part A: 16).

According to Damala and Stojanovic (2012) the physiological aspect of the project has important implications for CH institutions in providing and enabling a highly personalised visit and experience as well as for an understanding of the interrelationship between emotions, memory and learning. The experimental and innovative technology developed in the ARtSENSE project demonstrates how CH can interact with, and be relevant for, contemporary society. However the sustainability of the project was problematic. For example at FACT, Liverpool, the project is no longer running as stated by partner Roger McKinley, "Unfortunately due to circumstances beyond our control the ARtSENSE project was effectively wrapped up in 2012 without reaching any valuable conclusions" (Email 22/10/2015). The reasons were not explained and this raises issues of the sustainability of publicly-funded projects.

6. CASE STUDY 2: GHOSTS IN THE GARDEN

Funding: REACT (UK)

Collaboration: The Holburne Museum, Bath, UK, University of the West of England (UWE) and technology company Splash and Ripple,

> *Part game, part story, part immersive sound scape (accessed via a special 'Georgian Listening Device'), present-day visitors will meet and interact with real characters from the Gardens' heyday, in a unique experience where history and imaginative play meet head-on.*[92]

This case study explores the *Ghosts in the Garden* collaborative project in which innovative and experimental technology was employed to revitalize and reinvigorate the historical Georgian Sydney Gardens in Bath, England. It is an example of best practice in how existing technology can be used creatively to promote public engagement in the CH sector. *Ghosts in the Garden* was part of the 'Heritage Sandbox' series of projects initiated and supported by REACT in the UK and developed through an interdisciplinary collaboration between academic researchers, CH professionals and software designers.

This case-study outlines the background and rationale for *Ghosts in the Garden* within the context of REACT's 'Heritage Sandbox'. It discusses their aims in promoting collaboration between partners and developing projects which involve experimentation and innovation in DT with an emphasis on research, public engagement and impact and how this can contribute to the creative economy. It then discusses the development of the project *Ghosts in the Garden*, the concept, collaborative partnership and the technology contextualised within the changes in the CH sector brought about digital technologies. It demonstrates how collaborative working between a CH institution, research and technology can create experimental and innovative DT which can enhance the CH experience and have an impact on society and culture. By experimenting with innovative technology and engaging visitors in novel ways the CH sector can maintain and attract new audiences and have the potential to contribute to Europe's creative economy.

REACT: From wild ideas to working prototypes

The project *Ghosts in the Garden* was supported by REACT (Research and Enterprise in Arts and Creative Technology) which is funded by the UK's Arts and Humanities Research Council (AHRC).

[92] http://www.react-hub.org.uk/heritagesandbox/projects/2012/ghosts-in-the-garden/ [accessed16/06/2015].

It is one of four *Knowledge Exchange Hubs* for the Creative Economy in the UK developed by the AHRC who promote opportunities for collaboration between arts and humanities research in academia and the public and private sector, the aim of which is to increase the value and impact of research for the benefit of the creative economy and to translate research into the wider society.

REACT is a collaboration between five university research institutions in the UK: University of West of England (UWE) and the universities of Bath, Bristol, Cardiff, Exeter and Watershed, Bristol, UK. It is "an interdisciplinary lab, researching and producing new experiences".[93]

One of the aims of REACT is to encourage, promote and financially support collaborations between arts and humanities researchers and external creative and cultural industries (SMEs). The objective of these collaborations is to experiment in the development of DT as an investment for the future to ensure public engagement with research and to contribute to the creative economy. According to the director of REACT, Professor Jon Dovey, collaborations are based on shared values and inquiry into the transformation of knowledge and have brokered a new set of relationships which have in turn led to new ways of collaborative working between academics, technologists and the creative industries. In 2013, REACT had invested in over thirty projects and had developed three hundred collaborative partnerships between academic researchers and businesses.

In order for the CH sector to keep pace with changes in society and DT, Dovey emphasises the importance of creating new and immersive digital experiences for a new generation of CH visitors who are mobile and who use mobile technologies. He suggests that in order for the CH sector to answer to these challenges, they need to create new immersive forms of culture in what he terms the 'experience economy' that "offer audiences many ways into a body of material. We can experience media as a movie, a book, an app, a locative audio piece or even an installation … all public communicators need to become experience designers" (Dovey 2013: 19).

REACT: Sandbox

REACT primarily supports collaborative projects through the use of a Sandbox process. The concept for Sandbox was developed by Watershed, Bristol in 2008 and is designed as a support and funding scheme for new ideas. As one of the main partners in REACT, Watershed continued the idea of Sandbox to support collaborations between academics and companies,

[93] www.watershed.org [accessed 29/07/2015].

> *The Sandbox is a method for bringing people together in an ideas generation and prototyping process. It is a three month mentored programme which emphasises peer learning, iterative design and open sharing. REACT has adapted this methodology by building it around partnerships between academics in the Arts and Humanities and creative companies* (Dovey et al. 2014: 4).

Sandbox organises events for potential partners to meet, discuss ideas and develop collaborative projects. These are supported by a network of business and financial advisors as well as other relevant professional experts and mentors to discuss issues such as target audience, marketing, PR and sustainability. The process through which REACT funds projects is described by Dovey,

> *We decide on a theme with our business partners and we put out a call. We then invite people to come to our ideas labs, they then generate a bunch of ideas and connections and contacts, which we then curate into a series of applications and an applications procedure and we award money. The principle in this is crowdfunding diversity, trying to get lots of different kinds of people together from the ideas lab through to funneling them into this sandbox process.*[94]

REACT aimed to run two Sandboxes a year with themes that directly address contemporary issues in the creative economy based on academic research, innovation and public engagement. The themes to date are:

- Heritage
- Books and Print
- Future Documentaries
- Objects
- Play Sandbox[95]

[94] Professor Jon Dovey, Director, REACT, Bristol. Video of the AHRC Creative Economy Showcase 2014: http://thecreativeexchange.org/activity/video-creative-economy-showcase [accessed 15/08/2015].
[95] http://www.react-hub.org.uk/about/ [accessed 15/08/2015].

Heritage Sandbox

> *Technology is changing the way people travel, work, communicate and spend their leisure time. There is an explosion of new and extended ways to use web, mobile and projections to create rich and memorable interactions. For the heritage sector to remain relevant and sustainable, it must make sure it remains at the forefront of this wave.*[96]

The development of pervasive and immersive DT and the increasing use of personal mobile technologies such as the smartphone and tablet which allowed for access to the internet at anytime and anywhere, provided the grounds for the potential for the CH sector to engage with these emerging technologies as recognised by the REACT team. The REACT hub note that, "The relevance of pervasive and immersive DT to REACT enables the design of projects which can bring historical characters back to (virtual) life to retell their stories after archival research to reveal their stories and memories".[97]

REACT's Heritage Sandbox was launched in 2012 and supported six projects which aimed to enhance local CH experiences and to "unlock histories, hauntings and happenings in all kinds of UK heritage attractions, unraveling rich experiences through the use of cutting edge technologies".[98]

Heritage Sandbox aims to merge cutting-edge technology with in-depth research to reinvigorate heritage sites as engaging and interactive, to bring back historical characters in new and novel ways to engage visitors and to enhance their experience of CH. Using the latest and emerging technologies from augmented reality mirrors to Georgian listening devices and tweeting the dead, REACT'S heritage Sandbox aims to transform innovative ideas into experimental prototypes,

> *Heritage Sandbox supports collaborations with ground-breaking ideas that create innovative, meaningful experiences for the heritage sector. Projects could be an interactive installation for a museum, a new way of navigating a theme park, or a location aware game for a stately home.*[99]

[96] http://www.react-hub.org.uk/heritagesandbox/about/the-theme/ [accessed 16/06/2015].
[97] http://www.react-hub.org.uk/about/ [accessed 16/06/2015].
[98] http://www.react-hub.org.uk/heritagesandbox/about/the-theme/ [accessed 16/06/2015].
[99] http://www.react-hub.org.uk/heritagesandbox/about/the-theme/ [accessed 16/06/2015].

The idea of the Heritage sandbox is to develop new and innovative ways in which to experience CH and to provide the opportunity for the CH sector to fulfill their aspirations and to remain relevant for their existing audience and to attract a new generation of visitors. In using cutting-edge technology to engage and attract new audiences and to enable new ways to experience heritage,

> *Each project aims to deliver new ways to experience heritage attractions, through new kinds of social interaction enabled by pervasive media and immersive digital technologies. They explore contemporary attitudes to death and human remains in Cemeteries and Museums, giving the dead a technological voice and bring history back to life through interactive located archives using real memories and historical characters.*[100]

After identifying a theme, an ideas generation process helps to identify where regeneration, innovation and new thinking could be best placed such as a cultural institution, park, garden or city that may have low visitor numbers due to the lack of innovative ways to engage visitors. REACT assist and support the partnership and collaboration of such an institution with a relevant academic to enable them to research a project,

> *In the case of REACT, each Sandbox project is a genuine collaboration between an academic and a creative company. The importance of creating a fertile, shared space starts at interview, where six to eight applicants are carefully selected to become a cohort – the strength of the ideas balanced against the need to ensure diversity in platform, experience, market, potential and approach* (Reddington 2013: 4).

After selection and approval the team meet regularly in person and online to share existing knowledge, exchange ideas and begin to develop the project. One of the most important objectives is that the project succeeds in the real world and does not just exist as an idea and prototype and therefore continuous testing and evaluation of the project by potential visitors is encouraged throughout.

To date there are six Heritage Sandboxes:

- ***The Future Cemetery*** is an interactive smartphone app created to enable an immersive experience to make cemeteries more accessible and engaging (Dr John Troyer, Calling the Shots and Arnos Vale Cemetery)
- ***Reflecting the Past*** uses augmented reality mirrors on board Bristol's SS Great Britain (Dr Tim Cole, Interactive Places and SS Great Britain)

[100] http://www.react-hub.org.uk/heritagesandbox/about/the-theme/ [accessed 16/06/2015].

- ***The Ivory Bangle Lady*** is a pervasive media project to enhance the museum experience to enable visitors to commune and tweet with the dead (Prof. Christopher Knusel, Stephany Leach and Imagemakers)
- ***The Memory Theatre*** is a project that explores the relationship between archives and memories Dr Paul Clarke, Bristol Old Vic and Pyxis Design)
- ***Ghosts in the Garden*** is based on multi-sensory pleasure gardens in Bath (Dr Steve Poole, Holburne Museum and Splash and Ripple)
- ***City Strata*** is a mobile platform that enables users to explore different layers of Bristol's heritage. Based on time-travel and using a combination of DT and in-depth research, historical characters are brought back to life to retell stories to enable new experiences in parks, gardens and cities (Dr Charlotte Crofts, Clavium and Bristol City Council).

REACT Executive Producer Clare Reddington states,

> *The six Heritage Sandbox projects are great examples of the new ways of thinking that can be achieved by bringing together arts and humanities research with creative companies. REACT is about supporting unusual partnerships and brilliant ideas. The six Heritage Sandbox projects are great examples of the new ways of thinking that can be achieved by bringing together arts and humanities research with creative companies.*[101]

GHOSTS IN THE GARDEN

This case study is specifically concerned with the *Ghosts in the Garden*, (2012), one of the Heritage Sandbox projects at REACT. The project aimed to recreate Sydney Gardens, the Georgian Pleasure Gardens of Bath, UK, where present-day visitors could engage with and meet historical characters through archive research, soundscape and live action game, all centred around a 'Georgian Listening Device' now referred to as a 'Time Radio'. It was collaboration between Dr Steve Poole, Professor of History and Heritage, University of the West of England (UWE), UK, Alexander Sturgis, Director of the Holburne Museum in Bath, UK, Rosie Poebright, Director of technology company Splash & Ripple who describe themselves as 'Architects of the Extraordinary' and "to make beautiful, genuinely moving experiences that put the participants at the centre of the action using theatre, gaming, and digital technology".[102] The team also worked in partnership with Amalgam Model-makers, Fire Springs Storytellers, two scriptwriters, actors and Artist in Residence at Holburne Museum, Karen Wallis.

[101] http://www.thedrum.com/news/2012/03/28/heritage-sandbox-south-west-heritage-ideas-win-grants [accessed 30/07/2015].

[102] http://www.splashandripple.com/ [accessed 16/08/2015].

Sydney Pleasure Gardens is one of the oldest public gardens in Bath and was designed and developed in 1795 by the architect Charles Harcourt Masters. It is situated in Sydney Road, a residential area north-east of the city of Bath, UK. The twelve acres of gardens included the Sydney Hotel which is now the Holburne Museum, the first public art gallery in Bath which houses the collection of Sir William Holburne. Famous visitors to the gardens included members of the royal family and the author Jane Austen who lived at Sydney Place. The original Georgian pleasure gardens was a bustling and busy place famous for its labyrinth, swing-boats, and 'Cosmorama' (an exhibition of images of parts of the world) and spectacular Gala evenings featuring fireworks, ropedancers and illuminations. It was purchased by Bath City Council and made into a municipal park in 1909 and no trace of its former uses has survived. *Ghosts in the Garden* deals with time-travel and aims to reinvigorate the gardens to bring them back to life through using DT in a new and innovative way. It aims to create a visitor experience that will transport the visitor back into history to meet and interact with historical characters, listen to their stories and respond to them. For the Holburne Museum, originally the grand entrance to the Gardens, but now a separate entity at one end of the park, the project was "an opportunity to encourage visitors to reconnect the two components and understand them as a whole. The Museum's director was therefore very supportive of the project and keen to make it a three-way partnership" (Steve Poole email 24/09/2015).

According to academic partner, Steve Poole the project was developed iteratively and with few preconceptions about the outcome, but some important principles of innovation were established. These included,

- Hidden technology
- Group experience (family play)
- User agency
- A rejection of 'passive' tourism
- Education through stealth

Research

Archival research was undertaken by historian- academic researcher and project partner, Steve Poole to build biographical details around previously overlooked historical characters who actually worked in or visited the gardens in the period 1823-1826. Stock heritage figures like Jane Austen were purposefully avoided so that new histories 'from below' could be brought into play, offering visitors a cast list of unfamiliar but researched and real characters from the middle and lower classes or "pimps and pickpockets rather than Kings and Queens" (Dovey 2013: 19). This research revealed much that was previously unknown about the lives of everyday people in the Gardens, from circus performers and impresarios, to labourers, beggars, thieves and constables.

For example, an original eighteenth-century musical score by James Brooks, the Director of musical entertainment at Sydney Gardens was uncovered during research by Dr Matthew Spring of Bath Spa University. The project enabled this music to be performed and recorded, and then added to the soundscape audio experience for the project.

> *Professional storytellers then worked with the project team to help them imaginatively flesh out the characters, and create historically-based narratives and scenarios in which to situate them. Sound designers and scriptwriters then worked with Poebright at Splash & Ripple to further develop the narratives by adding a 'choose your own adventure' game mechanic so that a variety of interpretations and outcomes would be made available to visitors who engaged with the experience. Two stories were developed, both based on historical research; one concerning the theft of a hot air balloon and an economically exploited rope dancer and the other a disgraced prison governor and the malicious sabotage of a firework display (!) The scenes, game mechanic and soundscape were extensively tested and then recorded, using professional actors* (Steve Poole email 24/09/2015).

The Holburne Museum wanted their visitors to experience this exciting history of the garden, the life that went on there and the layers of history of where we are today, but to experience it in a new and different way. As described Steve Poole,

> *Ghosts in the Garden is about place – a distinctive place - it's about history, pleasure gardens and a park that people walk in all the time without necessarily thinking about who has walked here before. So to uncover some real history, to think about the discipline of how we discover the real histories, how we put people from the past back into the land in which we walk is valuable, so much better than making it up.*[103]

Poole and Poebright wanted to create an experience that reflected some of the ways in which historians absorb and interact with fragments of evidence to piece together narratives and interpretation. Rather than let visitors think they were being instructed about the history of pleasure gardens by an 'authoritative voice' or guidebook, *Ghosts in the Garden* draws them into an uncertain historical world and requires them to listen, form opinions and make choices, based on the evidence presented.

[103] Dr Steve Poole https://vimeo.com/60239838 [accessed 16/08/2015].

However, the material is created in advance with only a limited number of options, so that there is a question around the limits of active agency, as is the case with most interactive work.

An important part of the project, therefore, was the Character Booklet, given to each participant at the conclusion of their visit. This presents them with short illustrated historical biographies of each 'Ghost', together with notes explaining how/where the research was done and how to find out more. Visitors are then able to evaluate how much 'learning' they have done, just by playing the game.

The Technology

The technology company Splash and Ripple aim to offer heritage sites a radical new approach to interpretation using new technology and game design. When they were asked to design a 'mobile app game' for Sydney Gardens, their priority was about the kind of experience the audience would have and how they could learn about the history of the gardens in a different way. They decided that a game would be the best format to do this "people learn from the choices they make – but the real art is in also enabling them to understand the space on their own terms through a powerful experience which they are in control of".[104]

To access and listen to the stories of real characters from the gardens history Amalgam Model-makers of Bristol were commissioned to design a 'Georgian Listening Device' or Time Radio in the shape of a simple wooden box, intricately decorated with mysterious dials and levers to evoke a Georgian air of invention and wonder.

Wooden Georgian 'Time Radio'
Copyright: Laurens Knockles

Ghosts in the Garden Image: Time Radios:
http://www.splashandripple.com/ghostsinthegarden

[104] http://www.splashandripple.com/ghostsinthegarden [accessed 16/08/2015].

> *The design of the box was vital to the concept. Visitors are urged to enter the historical/imaginary world of the project by believing they are holding something old, magical and precious, not just a tablet or smartphone. The intention throughout was to conceal the technology and make it as simple to use as possible* (Steve Poole email 24/09/2015).

Using locative technology based on a navigation system, the chest contains and conceals a Global Positioning System (GPS), a satellite navigation enabled 'Minirig' (wireless portable speaker) which responds to different locations to tell a story. The visitor is given the wooden Time Radio, which they take into the garden with them together with some very simple instructions, and a map on which original features like the labyrinth and the Cosmorama have been reinstated.

> *The box broadcasts the sounds of a Gala Evening and the voices of the researched characters, which directly address the visitors and solicit their assistance as they move around the garden. Choices have to be made over who to believe, who to help, or who to follow, so that visitors become active accessories in the playing out of each narrative* (Steve Poole email 24/09/2015).

The past is brought to life in the real-time present and the visitor has to suspend normality. This gives a physical connection to the past, as described by Splash and Ripple, "it was a busy bustling place with all kinds of things happening and we want people to go away with that experience".[105]

Copyright IPR

The collaboration and co-design in any project raises issues of authorship and ownership. REACT acknowledge that IP is a crucial part of any collaboration and potential partners who attend a Sandbox event to share ideas have to conform to a set of IP criteria. This is to ensure confidentiality of ideas and concepts and ensures that all partners are aware of IP issues before any partnership or technology is developed.[106]

[105] Rosie Poebright, Director Splash and Ripple on Vimeo (https://vimeo.com/60239838) [accessed 16/08/2015].
[106] REACT copyright terms are available at http://www.react-hub.org.uk/about/
For a discussion on the copyright issues in Ghosts in the Garden see School of Law Working Paper Series, University of Edinburgh and Kheria, Smita and Waelde, Charlotte and Levin, Nadine, Copyright and Publicly-Funded Arts and Humanities Research: Identifying and Developing Sustainable Exploitation Models in the Digital Economy (October 19, 2015). Edinburgh School of Law Research Paper No. 2015/33. Available at SSRN: http://ssrn.com/abstract=

Conclusion

Ghosts in the Garden is an example of human experience at the heart of experience design and demonstrates best practice in the digital economy and the future of museums and CH. For the duration of its run, *Ghosts in the Garden* enhanced and enriched the visitor experience of CH at the Holburne Museum and Sydney Gardens and by using DT to design an immersive and interactive experience it improved their public engagement programme. REACT note that, "Since completing REACT's Sandbox *Ghosts in the Garden* has helped Bath's Holburne museum to enrich visitors' time in the gardens and increase the amount of time visitors stay on site".[107]

The success of *Ghosts in the Garden* was summed up by Rosie Poebright, Director of Splash and Ripple who stated,

> *People are coming back, they're talking about how they feel about the space and using language about imagining what it was like, that it was evocative and the soundscape made them imagine what it was like when it was a pleasure garden, and that was exactly what we were trying to achieve.*[108]

For Jon Dovey, the Director of REACT, the success of the project was due to the interdisciplinary collaboration and to putting people at the centre of the design process or what he terms 'experience design'. This allows for an understanding of the nature and quality of human experience as lived cultural phenomena.

The project has had a positive outcome for Holburne Museum in terms of being:

- Social and democratic in enhancing the visitor experience as people engage with local historical characters to consider their local heritage and identity. This reflects the "re-conceptualisation of the ways in which CH can reflect, construct and enrich individual and collective identities, and represent these identities more fully, within a context of continuing social change" (RICHES DoW Part 2: 4)
- Educational in creating new knowledge about the gardens through user-generated learning in a novel way where the visitor is in control of how much they want to see and learn
- Economical in terms of increasing visitor numbers, returning visitors and increased time spent at the museum
- Technology could be exploited in other learning situations and by schools

[107] *REACT Collaborations* 2012-2013 (2013: 11). Available at: http://www.react-hub.org.uk/sites/default/files/REACT%20Collaborations_0.pdf [accessed 02/08/2015].

[108] Rosie Poebright, *Ghosts in the Garden* on https://vimeo.com/60239838 [accessed 16/08/2015].

This was achieved by:

- Emphasising the importance of the 'experience economy'
- Putting people at the centre of the design process
- Creating an immersive and interactive experience
- Using a geo-locative game technology which is playful
- A shared process of experimentation through collaboration

Ghosts in the Garden was funded for a limited amount of time and is no longer running as a permanent visitor attraction at Holburne as there was no budget, and this raises questions about the sustainability of such projects. In order for DT projects to continue after the initial funding there needs to be a culture change in the CH institution itself where digitisation is part of the institutional strategy for the future. According to Poole, the Time Radio can be revived very easily and at any time but this will rely on the initiative and motivation of the CH institution to implement it. However, the Director of the Holburne Museum has left his post and the new Director may have different priorities.

The project has been valuable for the partners' involved and instigated future research. For example, the inspirational experience that Splash and Ripple had in dealing with original historical research and interpretation has led to a more permanent partnership with Steve Poole, who is also now the company's honorary associate historian. The team have pitched for further work in the commercial heritage sector as a result and won a £100,000 contract with the National Trust in 2013 to build a similar visitor experience at Bodiam Castle, East Sussex. This project, 'A Knight's Peril' is now a permanent visitor attraction at the Castle.

Ghosts in the Garden highlights the importance of funding-bodies in supporting experimentation and innovation in DT, and taking risks with new ways of thinking and new practices. Reddington comments that, "All will be enriched and changed by a shared process of experimentation. And all will have helped us shape and refine a funding process designed holistically, to support risk, encourage difference, and create meaningful collaborations for years to come" (Reddington 2013: 5).

Ghosts in the Garden is an example of change in the CH sector and of the new ways of thinking that can be achieved by bringing together arts and humanities research with creative companies and is a radical way to approach interpretation **a**nd CH through DT. REACT has transformed the way research academies and the creative industries work together to create wealth and value for the UK creative economy. In combining research with cutting-edge technology, it realises the potential to enhance and engage new audiences. As described by Simon Moreton, Research Fellow at REACT,

> *We know that good collaborations come from minimising bureaucracy, valuing intuition and hunches, being accountable and open to change, and being able to adapt quickly to challenges and opportunities. These are not just desirable outcomes, but essential components of how innovation can be supported* (Moreton 2013: 20).

Projects such as *Ghosts in the Garden* changes the ways of working for both academics and CH professionals through collaboration with each other and sharing ideas and knowledge and in doing so changes the relationship between them. By designing interactive, immersive and engaging experiences, it also recalibrates the relationship between the CH institutions and its visitors.

Ghosts in the Garden is a successful example of collaboration of grounded academic research into CH history with DT and the transformation of ideas into the creation of an innovative prototype product applied to a CH location to create new experiences in CH. The collaborative partnerships, the experimental and development of innovative technology, which aims to engage visitors and place them at the centre of the design process, can be considered as important factors in the shaping of the future for the CH sector.

7. CONCLUSION

> *Experimentalism is not just a matter of style or novel forms of presentation. Rather, it is a risky process of assembling people and things with the intention of producing differences that make a difference. In their production of something new experiments seek to unsettle accepted knowledge or the status quo* (Macdonald and Basu 2007: 17).

This deliverable has mapped some of the best practice in experimentation and innovation in DT in the CH sector and has demonstrated the cultural shift in museum practice through the use of digital technology and the "profound recalibration of the relationship between institutional CH practices and the individual which has largely been brought about by the advent of digital technologies" (RICHES DoW Part B: 5). The examples of best practice discussed in the deliverable were achieved through interdisciplinary collaborations between CH institutions, academic research institutions and external technology agencies. This demonstrated that CH institutions are open to collaboration and experimentation in implementing digital content into the physical space of the institution as well as beyond its walls.

The purpose of this deliverable was not just to discuss experimentation and innovative DT and its implementation in a CH institution. Contextualised within the aims of the RICHES project, the tenor of the deliverable was to assess the way in which DT have permeated the CH sector and highlight the changing practice of CH institutions in interdisciplinary collaborations and partnerships. It aimed to show that it was not just about change in practice and different modes of working, but that social change and participation in CH has been brought about through the use of experimenting with new technology. In this sense, new technology has the potential to be transformative in how we access, communicate and disseminate European CH. This transformation also affects CH professionals in recalibrating their relationship with other CH institutions, external agencies, such as research academies and, most importantly, their audience. Indeed, it can be argued that the future of CH and DT are fundamental to these new relationships.

The outcomes of the deliverable demonstrated that engaging with new digital technologies and adopting new collaborative working practices can result in many new forms of access, interpretation and enhanced visitor experience. It exemplifies that "Research, innovation and new technologies … are essential for bringing the cultural heritage closer to the people".[109]

[109] European Parliament Resolution: *Towards an Integrated Approach to Cultural Heritage for Europe*: Section 44). Available at: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2015-0207+0+DOC+PDF+V0//EN

This, however, involves taking risks, investing time and effort to experiment, being entrepreneurial and relinquishing some institutional control in allowing the visitor to make decisions and contribute to an exhibit's interpretation and history.

Experimentation and innovation in DT is contingent on funding and the first chapter outlined some of the European policies, strategies, initiatives and funding bodies that support and encourage experimentation in DT in the CH sector. The CH sector is part of Europe's creative industries and is an important and vital part of Europe's economy. Investment and funding create opportunities and the conditions for experimentation and innovation in DT to take place. This was important to this deliverable as it highlighted the importance of the CH sector to European growth and the recognition of DT as a driver of change in the CH sector.

The CH sector can have cultural, social and economic value. Through experimenting and implementing new innovative technologies the CH sector can:

- Support economic growth
- Enhance visitor experience
- Recalibrate their relationship with the CH visitor

The deliverable highlighted the rapid changes and transformation of social life by technology and emphasised that in order for the CH sector to remain relevant for a contemporary audience and to attract new audiences, which in turn has the potential to increase revenue, it is crucial for the CH sector to keep pace with new and emerging DT to ensure future social and economic success. To benefit CH institutions need to be:

- dialogic
- open to collaborative working partnerships
- interdisciplinary
- competitive and entrepreneurial

The second chapter mapped the changes for CH in the context of collaboration with academic research institutions in the experimentation and innovation of DT.
This was contextualized within the changing nature and shifting practice in museums, in particular the idea of the 'participatory museum' brought about by the implementation of a variety of DT, which reflects changes in European society. This was achieved through a series of examples of best practice for improving and enhancing the visitor experience of CH through DT which has the potential to increase revenue.

The CH institution was situated as a social institution and in order to remain relevant to a contemporary audience they must adapt and change and that includes experimenting and innovating in DT to remain up to date and relevant, not only for their audience but also to continue, "Exploiting the potential of CH through DT in order to foster the economic growth of Europe" (RICHESDOW Part B: 10).

This demonstrated:

- The value of collaboration for all involved in the development of innovative approaches to CH adapted to user contexts and needs
- New working relationships between different departments in the CH Institution
- Identification for staff professional development and training in new skills
- New professional identities
- New and novel ways to communicate with their audience through DT

The chapter outlined the shifts in CH practice in becoming more democratic, participatory and user-centred. The digital has infiltrated and transformed all aspects of social life and the CH institution, as a social institution, is part of these changes. Many visitors are now digitally literate and emerging technologies will enable them to be constantly connected, anytime and anywhere. The benefits for the visitor include:

- CH visitors can control and adapt the information they require about CH
- CH visitors can participate and contribute to the interpretation of CH
- Visitors can co-create CH
- Enhanced CH experience

This comes with the caveat that DT has to be balanced with more traditional modes of engagement to cater for a diverse audience who may not be digitally literate. New practices, such as co-creation, are designed with the objective to give agency and power to the CH user but this is questionable. Research needs to be undertaken into the amount of agency and control the CH visitor actually has, whether the CH institution has relinquished part of their control, or to what extent they remain in control.

The examples of best practice included 'smart cities' and cultural tourism through DT, which are considered important for Europe's economic growth. The European Parliament note that, "Cultural tourism accounts for 40% of European tourism and is a key economic sector in terms of potential for growth and employment and should be further enhanced by new technologies".[110]

[110] European Parliament Resolution: *Towards an Integrated Approach to Cultural Heritage for Europe*: Section 29). Available at: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2015-0207+0+DOC+PDF+V0//EN.

This demonstrates the importance of experimentation and innovation in DT in the CH sector and the potential impact on Europe's economy.

Some projects also have a social impact. For example, the collaboration between Minecraft and the Tate Galleries, are ensuring that the younger generation are engaging and learning about their CH in ways that are fun and relevant to them. The social impact is in terms of the "cultural behaviour of young people, spending time and energies in activities hosted by cultural institutions" (RICHES DoW Part B: 59).

The two case studies were detailed examples of best practice when the CH sector works in collaboration with academic researchers and creative technology companies. By designing DT which are immersive and interactive and which give control to the CH visitor, they are examples of the "decentring of culture and CH away from institutional structures towards the individual" … and … "the disruption and transformation of hierarchies of knowledge" (RICHES DoW Part B: 4). They also demonstrate the RICHES Scientific and Technological Objectives, "To devise instruments and to elaborate methodologies for knowledge transfer, developing innovative skills, creating new jobs and exploiting the potential of CH through digital technologies in order to foster economic growth" (RICHES DoW Part B: 10). The case studies are examples of how DT are "profoundly influencing and shaping the environment of change in our society, they also open the way to new, distributed, ways of working, communicating and investigating new products and services in the CH sector, as in other sectors" (RICHES DoW. Part B: 5). Projects discussed in this deliverable aimed to demonstrate:

- The transformative potential of DT on CH
- A recalibration of the relationship between the CH institution and the academic research institution
- A recalibration of the relationship between heritage professionals (CH institutions) and heritage users (individual/audience)
- The importance and impact of CH on EU economic development in an information society
- A new economic order
- Outcomes of projects can be catalysts for further innovation and experimentation or transferable to other projects

Collaborations

Working in collaboration can have many benefits for all involved including access to funding. For example, Universities have experience in applying to funding bodies to finance their research projects. CH professionals should be aware of funding bodies and opportunities for research projects. There are many public-funded bodies that encourage and support innovation in DT for the CH sector and CH institutions should make these known to their staff.

Most cities have a university or academic research institution that undertakes research in DT. Many funding bodies require that 'knowledge transfer' is part of the criteria for a funding application to make sure that the research undertaken has a social impact. Museum professionals should be aware of research institutions in their area and investigate research projects.

Collaborative working also has challenges and it is important for the CH institution and the academic research institution to be aware of the requirements of each other such as:

- The time and financial constraints they may have to work under
- The aims and objectives of each partner
- Input from all partners should be valued equally
- Respect and trust in achieving the end goal
- Be open to new ideas and learn from different perspectives
- Awareness and knowledge of copyright and ownership issues when working in partnership

The design of DT for the CH sector should:

- Reflect the CH institution's digital strategy and purpose.
- The institution should have clear objectives and motivations for implementing DT
- Cater for a new and evolving digital audience.
- The CH user should be placed at the centre of the design process to ensure that the DT is user-friendly and appropriate.
- Take an iterative and flexible approach to the design process to allow for changing circumstances.
- The design of new technology should aim to create an immersive and interactive experience.
- Allow for an 'adaptive' and personalised experience of CH.

Challenges

The implementation of DT in the CH has opportunities and challenges. DT may have transformed society and the CH sector, but it is important to remember that it is not the only factor,

> *Museum digital technology cannot be used in isolation. These tools are important, but of equal importance is their relationship to other forms of museum interpretation, and of course, the visitors themselves* (Gray et al. 2013).

The use of technology in the CH institution may be described as "facilitating the opportunity to present the past not as a foreign country where things are done differently but as a place which is current and relevant. Technology is merely the facilitator to elaborate on the past, it is merely the medium" (Walsh 2014: 15).

An emphasis on DT in CH institutions to attract new audiences can sometimes be at the expense of those visitors who are not interested in technology and who may become disenfranchised. They need to cater for diverse interests and they need make sure there is a balance between the use of DT and more traditional modes of CH engagement. For example, Martin Roth, Director of the Victoria and Albert Museum, London, acknowledges that not every visitor wants to be interacted with on a visit to a museum, so there is also a desire on his part to keep some areas of the building for quiet enjoyment of the displays. He states, "The V&A is such a big institution that if someone wants to sit down in a gallery and meditate in front of an object then they will find that spot" … "If someone wants to get online amidst a noisy, vibrant crowd then they will find that too" (Roth quoted in Aitch 2015).

It has been emphasised throughout the deliverable that by investing in new technology CH institutions can maintain existing visitors and attract a new generation of visitors and this has the potential to increase revenue. CH institutions need to be clear and transparent in their objectives and motivations for implementing DT otherwise they may be open to the criticism of being unethical in that it is mainly for economic reasons rather than democratic engagement. A balance and a resolution will need to be reached to avoid this ethical dilemma.

Some of the projects raised issues of sustainability as they only last the lifetime of the funding. In many cases there is no follow-on funding and projects are simply abandoned or staff associated with a project may move to another institution. Some, however, are a catalyst for future projects through the relationships developed during the initial project in a continuum of experimentation and change.

The lack of sustainability may be due to time constraints on CH practitioners, or possibly due to a lack of technical skills. According to Andrew Prescott, Professor of Digital Humanities, University of Glasgow, the skills required for digitisation are limited,

> *Digital methods are becoming mainstream in the humanities, as digital humanities specialists always predicted they would, but both humanities scholars and digital humanities specialists seem curiously ill-prepared to meet the challenges this presents* (Prescott 2015:22).

The innovative DT has to be sustainable and have a life after the project. The deliverable recommends that sustainability should be part of the initial planning process and throughout the life of the project. Sustainability can be interpreted in different ways: it could be a project continuing; it could be one project providing the springboard for another; or it could be educational in learning from others in the CH sector.

In the European Parliament Resolution '*Towards an Integrated Approach to Cultural Heritage for Europe'* (September 2015), the Parliament is calling for the establishment of a portal of CH related initiatives. Section 7a focuses on three aspects:

- A database of tangible and intangible cultural objects
- Best practice in preservation and promotion
- Funding opportunities for CH
- Data on Conservation

This deliverable suggests that this could be extended to include the digitisation of CH and a portal of best practice in the experimentation and innovation in DT in the CH sector which this deliverable has set out to do. This would enable "research findings covering all aspects of cultural heritage and to link them so as to counter fragmentation in this area".[111]This gathering of data on digital projects has the potential for sharing expertise and knowledge, can avoid duplication of projects, create new projects and allow the "exchange of experience and best practices".[112]

[111] European Parliament Resolution: *Towards an Integrated Approach to Cultural Heritage for Europe*: Section 33). Available at: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2015-0207+0+DOC+PDF+V0//EN.
[112] European Parliament Resolution: *Towards an Integrated Approach to Cultural Heritage for Europe*: Section 39). Available at: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2015-0207+0+DOC+PDF+V0//EN.

Evaluation

There is a lack of tracking of DT projects beyond the funding period and there appears to be a lack of evaluation in terms of visitor experience or revenue growth. The outcomes of implementing DT in a CH institution need to be measured and evaluated. The deliverable suggests that projects need to have detailed feedback and visitor evaluation of the DT in order to continuously improve the technology and ensure that it is user friendly and sustainable for future use. Prior consultation with users to assess their needs should be an essential aspect of any project. CH professionals should be aware of methods of evaluation in order to assess the impact of the new technology on user engagement and experience and reveal how, and in what way, the visitor experience is being enhanced. This would identify strengths and weaknesses on which to base future projects. Information gathered would evidence the impact of the DT on the visitor and help to assess how it enhanced their experience of CH and to identify future DT projects. This would also have the potential to reveal new skills required in the CH sector and the educational potential of DT in CH.

A recommendation of this deliverable would be for further collaborative research projects which could track the sustainability of projects and thoroughly evaluate the social, cultural, institutional and economic impact of DT in the CH sector from the perspective of the both the CH professional, the CH institution and the CH visitor. Assessing and evaluating the adoption and impact of new and emerging DT in the CH sector can also reveal their importance and contribution to Europe's economy such as competitiveness, not just in Europe but on a global scale. This knowledge could be placed in a shared repository or online platform to be used for those seeking similar projects.

Interoperability

The projects described in this deliverable reveal that CH institutions tend to work in isolation from each other each with their own agenda leading to a fragmented situation. The development of DT is undertaken on a one-to-one basis – what works in one CH institution will not necessary work in another - and the visitor has to adapt to each institution leading to a lack of interoperability which, according to some will be detrimental to the future of the CH sector particularly in the light of emerging technologies such as the Internet of Everything (IoE),

> *That single-mindedness is flawed; tech companies need to work together because failing to unlock the value in IoE could be costly. McKinsey predicts the value of IoE will top $11tn by 2025, but without interoperability will stall at $7tn* (Kobie 2015).

This has important implications for the potential of the CH sector in contributing to Europe's economic growth. It also has implications for innovation and participation as interoperability can lower barriers to innovation and is fundamental to the creation of participation. The development of an online portal of experimental and innovative DT in the CH sector, discussed above, could help avoid fragmentation and could be an important resource in promoting the interoperability of DT between CH institutions.

The value of the CH sector lies in the quality and diversity of collections, objects, monuments and places. But value is also in how they are accessed, communicated, preserved and disseminated and experienced by society who may be changed and transformed by them. This deliverable suggested that one way in which this value can be achieved is through the use of DT to access culture and the ways in which we "engage with it, alter it, how we communicate and participate in it, can be transformed through the use of digital technologies" (RICHES DOW Part A: 18). By collaborating with academic research institutions and working in interdisciplinary teams, this deliverable has shown that CH institutions can access and share ideas, knowledge and skills in the development of DT. The research undertaken in academic institutions and the knowledge produced, is no longer confined to the institution, rather it is being practically applied and is having an impact on society, culture and the creative economy. In doing so it "narrows the gap between the experimental in the research institution and its practical implementation in the digital economy" (RICHES DOW Part A: 18). Collaborative projects in experimentation and innovation in DT will enable the CH sector to continue to be involved in the digital renaissance and to have the potential to contribute to European economic growth.

8. REFERENCES

Aitch, Iain (2015) *The Global Museum* available at: http://artsdigitalrnd.org.uk/features/the-global-museum/ [accessed 03/09/2015].

Arts and Humanities Research Council*, Digital Transformations Final Report 2012*. http://www.digitaltransformations.org.uk/main/wp-content/uploads/2012/10/AHRC-DT-final-report-October-2012.pdf.

Bakhshi, Hasan, *Digital R&D Fund for the Arts: Digital Culture: How arts and cultural organisations in England use technology.* Final Report available at: http://artsdigitalrnd.org.uk/wpcontent/uploads/2013/11/DigitalCulture_FullReport.pdf.

Bakhshi, Hasan, Ian Hargreaves and Juan Mateos-Garcia (2013) Nesta's *Manifesto for the Creative Economy.* http://www.nesta.org.uk/publications/manifesto-creative-economy.

Bennett, T (1995) *The Birth of the Museum: History, Theory, Politics*. London: Routledge.

Black, Graham (2011) *Transforming Museums in 21st Century* London: Routledge.

Cameron, Fiona and Kenderdine, Sarah (eds.) (2007/2010) *Theorizing Digital Cultural Heritage*: *A Critical Discourse*, Cambridge and London: M.I.T. Press.

Chilcott, Laura (2015) *Working with the University and the Museum.* Available at: http://artsdigitalrnd.org.uk/insights/working-with-the-university-and-the-museum/ [accessed 03/09/2015].

Clifford, J (1997) *Routes, Travel and Translation in the late Twentieth Century*, Cambridge, Massachusetts: Harvard University Press.

Comité des Sages'*The New Renaissance*, Report of the 'Comité des Sages' Reflection group on bringing Europe's Cultural Heritage online (2011). PDF available at: http://europa.eu/rapid/press-release_IP-11-17_en.htm?locale=nl

Damala, A. and Stojanovic, N. (2012) *Tailoring the Adaptive Augmented Reality (A2R) Museum Visit: Identifying Cultural Heritage Professionals' Motivations and Needs*. IEEE International Symposium on Mixed and Augmented Reality 2012 Arts, Media, and Humanities Proceedings 5 - 8 November 2012, Atlanta, Georgia. PDF available at: http://www.researchgate.net/publication/230857100 [accessed 08/08/2015].

Damala, A., Stojanovic, N., Schuchert, T., Moragues, J., Cabrera, A., and Gilleade, K. (2012) 'Adaptive Augmented Reality for Cultural Heritage: ARtSENSE Project', in M. Ioannides et al. (eds.): *EuroMed 2012*, LNCS 7616, pp. 746–755, 2012. Springer-Verlag:

Berlin Heidelberg.

Digital R&D Fund for the Arts: *Digital Culture: How Arts Organisations in England use Technology.* http://artsdigitalrnd.org.uk/wp-content/uploads/2014/12/Digital-Culture-2014-Research-Report2.pdf.

Dodd et.al. (2015) *Talking Statues: The User Experience.* A Report for Sing London by the Research Centre for Museums and Galleries, University of Leicester. PDF available at http://www.le.ac.uk/rcmg [accessed 29/08/2015].

Dovey, J., Moreton, S., S. Sparke and B. Sharpe (2014) Curating Connectivity: Working Paper 3. REACT Hub, Bristol. PDF available at: http://www.reacthub.org.uk/sites/default/files/WORKING%20PAPER%203%20Curating%20Connectivity.pdf.

Dovey, Jon (2013) *The Experience Economy* in REACT *Collaborations 2012-2013*. REACT Hub, Bristol. http://www.react-hub.org.uk/sites/default/files/REACT%20Collaborations_0.pdf [accessed 02/08/2015].

European Parliament (2015) *Towards an integrated approach to cultural heritage for Europe*. European Parliament Resolution of 8 September 2015 (2014/2149(INI)). Available at: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+REPORT+A8-2015-0207+0+DOC+PDF+V0//EN.

Flew, T. (2005) 'Creative Economy' in J. Hartley (ed.), *Creative Industries* Oxford, U.K: Blackwell (pp. 344-360).

Freedman, G. (2000) 'The changing nature of museums', *Curator: The Museum Journal* 43 (4): 295-306.

Fyfe, Hamish (2014) *5 Ways to Build Successful Relationships with Academic Researchers* http://artsdigitalrnd.org.uk/features/5-ways-to-build-successful-relationships-with-academic-researchers/ [accessed 03/09/2015].

Gauntlett, D (2012) *Onwards and Upwards for Digital Transformations* http://www.digitaltransformations.org.uk/onwards-and-upwards-for-digital-transformations/

Goodhall, S and P. H. Lewis, K. Martinez, P.A.S. Sinclair, F. Giorgini, M.J. Addis, C. Lahanier, J. Stevenson (2004) *Knowledge Based Explorations of Multimedia Museum Collections*. PDF available at: http://eprints.soton.ac.uk/260899/1/EWIMTLongVersion.pdf.

Gray, Steven, Claire Ross, Andrew Hudson-Smith, Melissa Terras and Claire Warwick (2012) *QRator project 'Enhancing Museum Narratives with the QRator Project: a Tasmanian devil, a Platypus and a Dead Man in a Box';* University College London, UK

http://www.museumsandtheweb.com/mw2012/papers/enhancing_museum_narratives_with_the_qrator_pr Project website: (http://www.qrator.org) [accessed 22/07/2015].

Grinstead, Tom (2015) *Making Digital Work: Mobile: Sharing the Learning from the Digital R & D Fund.* PDF available at: http://artsdigitalrnd.org.uk/wpcontent/uploads/2015/06/DigitalRDFundGuide_Mobile.pdf [accessed 03/09/2015].

Heritage Portal.com - *EC Communication Towards an Integrated Approach to Cultural Heritage for Europe* European Commission Press release Brussels, 22 July 2014 https://ec.europa.eu/digital-agenda/en/future-emerging-technologies-fet [accessed 22/07/2015].

Hooper-Greenhill, E. (ed.) (1995), *Museum, Media, Message,* London: Routledge.

HORIZON 2020: The EU Framework Programme for Research and Innovation (http://ec.europa.eu/programmes/horizon2020/what-horizon-2020).

Johnson, L., Adams Becker, S., Estrada, V., and Freeman, A. (2015). NMC Horizon Report: 2015 Higher Education Edition. Austin, Texas: The New Media Consortium.

Joint Programming Initiative (JPI) *Cultural Heritage and Global Change: Report on Drivers of Change and the Future of Cultural Heritage: A Review to support the development of the Strategic Research Agenda (2014)*. Centre for Research in Futures and Innovation, University of Glamorgan, UK with CM International (no date) https://ec.europa.eu/digital-agenda/en/future-internet [accessed 1/06/2015].

JPI Cultural Heritage and Global Change: Report on Drivers of Change and the Future of Cultural Heritage: A Review to support the development of the Strategic Research Agenda (2014). Centre for Research in Futures and Innovation, University of Glamorgan, UK with CM International. Available at: http://www.jpi-culturalheritage.eu/wp-content/uploads/JPI-Cultural-Heritage-Drivers-Synthesis-Report-final-version-to-be-published.pdf.

Joint Programming Initiative (JPI) *Cultural Heritage and Global Change: Strategic Research Agenda* (www.jpi-culturalheritage.eu).

Keene, Suzanne (1998) *Digital Collections: Museums and the Information Age*, London: Routledge.

Kidd, Jenny (2014) *Museums in the New Mediascape*, London: Ashgate.

Kobie, Nicole (2015) 'Knitting together the internet of everything' in *The Guardian* Tuesday 18 August 2015. http://www.theguardian.com/media-network/2015/aug/18/internet-of-everything-things-interoperability [accessed

01/09/2015].

Koers, W., Annelieke van der Giessen, Marc van Weelden, Julianna Becker (2012) *Future of Cultural heritage: Impact of External Developments*. Background Paper to the 18 December 2012 European Policy Workshop, Brussels.

Loïs Tallon and Kevin Walker (eds.), (2008) *Digital Technologies and The Museum Experience: Handheld Guides and other Media*. New York and Plymouth UK. AltaMira Press.

Lomas, H., Hutcheson, N. and Dawson, A. (2012) *Collections Access and the Use of Technology in Museums*. A report by Norfolk Museums and Archaeology Service and the Collections Trust, UK: http://sharemuseumseast.org.uk/shares/resource_139.pdf [accessed 06/07/2015].

Lumley, R. (ed.) (1988) *The Museum Time Machine*, Routledge: London and New York.

Macdonald, Sharon (1998) Exhibitions of Power and Powers of Exhibitions: An Introduction to the Politics of Display in Macdonald, S (1998) *The Politics of Display: Museums, Science, Culture*. London: Routledge.

Macdonald, Sharon and Basu Paul (eds.) (2007) *Exhibition Experiments*, Oxford: Blackwell.

Mannion, Shelly (2011) *British Museum – Augmented Reality: Beyond the Hype* http://www.museum-id.com/idea-detail.asp?id=336 [accessed 31/08/2015].

Mayr, Eva and Wessel, Daniel, (2007) *Potentials and Challenges of Mobile Media in Museums* http://www.iwm-kmrc.de/museum/publications/IMCL2007_MayrWessel.pdf [accessed 09/07/2015].

Mcguinness, Victoria (2011) *Museums in the Digital Age: widening engagement or creating organisational conflict?* Available at: www.torch.ox.ac.uk [accessed 04/07/2015].

McKeown, Justin (2014) 'Art and the Internet of Things: a turning point in creative education' *The Guardian* 5 May 2014 (http://www.theguardian.com/culture-professionals-network/culture-professionals-blog/2014/may/05/art-internet-of-things-education-society) [accessed 04/05/2015].

McKinley. R and Damala, A., (2013) 'ARtSENSE and Manifest.AR: Revisiting Museums in the Public Realm through Emerging Art Practices'. In *Museums and the Web 2013*, N. Proctor & R. Cherry (eds). Silver Spring, MD: Museums and the Web. Published 31 January 2013. Consulted 27 July 2015. http://mw2013.museumsandtheweb.com/paper/artsense-and-manifest-ar-revisiting-museums-in-the-public-realm-through-emerging-art-practices/

Message, Kylie (2006) *New Museums and the Making of Culture,* Oxford: Berg.

Mitchell, Sam (2015) *Is mobile the next frontier in audience engagement within the arts?* http://artsdigitalrnd.org.uk/features/mobile-video/ [accessed 03/09/2015].

Moreton, S. (2013) *New Ways of Working?* In REACT *Collaborations* 2012-2013. http://www.react-hub.org.uk/sites/default/files/REACT%20Collaborations_0.pdf [accessed 02/08/2015].

Moussouri, Theano and Roussos, George (2015) 'Conducting Visitor Studies Using Smartphone-Based Location Sensing'. *Journal on Computing and Cultural Heritage*, Volume 8 Issue 3, May 2015. Article No. 12.

Navarette, Trilce (2014) A history of digitization: Dutch museums. PhD thesis: http://dare.uva.nl/document/2/153705

NeDiMAH *Beyond the Digital Humanities* http://www.nedimah.eu/reports/beyond-digital-humanities

Nesta Report (2014) *Digital Culture: How Arts and Cultural Organisations in England Use Technology*. http://artsdigitalrnd.org.uk/wp-content/uploads/2014/12/Digital-Culture-2014-Research-Report2.pdf [accessed 04/09/2015].

Parry, R. (2007) *Recoding the Museum: digital heritage and the technologies of change.* Oxford and New York: Routledge.

Parry, R., ed. (2009) *Museums in a Digital Age.* London & New York: Routledge.

Pilu, Maurizio(2015) in Nicole Kobie '*Knitting together the internet of everything'* in The Guardian Tuesday 18 August 2015 http://www.theguardian.com/media-network/2015/aug/18/internet-of-everything-things-interoperability [accessed 01/09/2015].

Porsdam, Helle (2015) in *NeDiMAH: Beyond the Digital Humanities*, http://www.nedimah.eu/reports/beyond-digital-humanities

Pratt, Mary Louise (1992) *Imperial Eyes: Travel Writing and Transculturation*, London: Routledge.

Prescott, Andrew (2015) in *NeDiMAH: Beyond the Digital Humanities*, http://www.nedimah.eu/reports/beyond-digital-humanities

Reddington, Clare (2013) *REACT: The Journey so Far* in REACT *Collaborations* 2012-2013 http://www.react-hub.org.uk/sites/default/files/REACT%20Collaborations_0.pdf [accessed 02/08/2015].

Roberts, Darren (2015) *Making Digital Work: Mobile.* Video available at:

http://artsdigitalrnd.org.uk/features/mobile-video/ [accessed 03/09/2015].

Roth, Martin (2011) *Museums in the Digital Age: widening engagement or creating organisational conflict?* Available at: www.torch.ox.ac.uk accessed 04/07/2015.

Roth, Martin in Aitch, Iain (2015) *The Global Museum* available at: http://artsdigitalrnd.org.uk/features/the-global-museum/ [accessed 03/09/2015].

Runnel, P. and Pruulmann-Vengerfeldt, P. (2014) *Democratising the Museum: Reflections on Participatory Technologies*, Peter Lang GmbH; Bern.

Runnell, P and Pruulmann-Vengerfeldt,P. (2012) *Theorising Museum Participation* in Proceedings of the DREAM conference, *The Transformative Museum,* 23-25 May 2012, Roskilde University, Denmark. Edited by Erik Kristiansen (2012). (http://www.dreamconference.dk/).

Russo, Angelina, Jerry Watkins, Lynda Kelly and Sebastian Chan 'Participatory Communication with Social Media' *Curator* 51/1 January 2008.

Sandvik, Kjetil (2012) *Mixed media, ubiquitous computing and augmented spaces as format for communicating culture: Communicating the history of Kolding (DK) through an augmented reality game using mobile phones, a web 2.0 mesh-up, a playable conspiracy plot, and the city as game universe.* Proceedings of the Dream Conference: The Transformative Museum, Roskilde University, Denmark, 23.-25. May 2012. Edited by Erik Kristiansen (2012). (http://www.dreamconference.dk/).

Simon, Nina. (2010), *The Participatory Museum,* Santa Cruz, California: museum 2.0.

Smith, L (2006) *Uses of Heritage*. London: Routledge.

Srivastava, Lara (2011) *Back to the Future*. A presentation on *The Internet of Things* given at the European Commission *Internet of Things Conference* in Budapest, 16 May 2011. Available on YouTube: https://www.youtube.com/watch?v=CJdNq7uSddM&feat.

Stuart, Phil http://preloaded.com/museums-20-how-ibeacons-will-revolutionise-museum-and-cultural-spaces/03/09/2015 [accessed 03/09/2015].

van Mensch, P. (2005), 'Annotating the Environment. Heritage and New Technologies', *Nordisk Museologi,* 2005:2, pp.17-27.

Vattano, Starlight (2014) *Smart Technology for smart regeneration of cultural heritage: Italian smart cities in comparison*. Available at: http://mwf2014.museumsandtheweb.com/paper/smart-technology-for-smart-regeneration-of-cultural-heritage-italian-smart-cities-in-comparison/) [accessed 12/09/2015].

Vergo, P. (ed.) (1989) *The New Museology*, London: Reaktion.

Vissor, J (2014) Keynote speech at the Canadian Museums Association Conference 2014. http://themuseumofthefuture.com/2014/04/18/museums-in-times-of-social-and-technological-change/ [accessed: 18/06/2015].

Vlahakis, V. et al. (2002) 'ArcheoGuide: An Augmented Reality guide for Archaeological Sites', in *Computer Graphics in Art History and Archaeology* September/October 2002: 52-60.

Walsh, Brian (2014) 'Walking Forwards, Looking Backwards: Using New Technology to Put Local History on a Global Platform' *Social History in Museums*, Vol 38, ISSN 2055-6977. Published by the Social History Curators Group 2014, pp.11-15.

Weibel, P. and and Latour, B. (2007) 'Experimenting with Representation: Iconoclash and Making things Public' in Macdonald, Sharon and Basu Paul (eds.) (2007) *Exhibition Experiments,* Oxford: Blackwell.

Wilson, R (2010) 'Rethinking 1807: Museums, Knowledge and Expertise'. *Museum Society* 8 (3) 165-179).

WEBSITES

http://artsdigitalrnd.org.uk/features/mobile-video/ [accessed 03/09/2015]

http://artsdigitalrnd.org.uk/wp-content/uploads/2013/11/DigitalCulture_Summary.pdf [accessed 02/09/2015]

http://artsdigitalrnd.org.uk/wp-content/uploads/2013/11/DigitalCulture_Summary.pdf [accessed 02/09/2015]

http://thecreativeexchange.org/tkex [accessed 03/07/2015]

http://www.bristol.ac.uk/education/events/2015/hidden-museum.html [accessed 03/09/2015]

http://www.labs.bristolmuseums.org.uk/category/hidden-museum/

https://ec.europa.eu/digital-agenda/en/digital-single-market#Article [accessed 24/08/2015].

www.torch.ox.ac.uk [accessed 04/07/2015]