

“Digital Interpretation Tools for Heritage”

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Masters in Fine Arts (in Digital Arts)

at the Faculty for Media and Knowledge Sciences (MaKS)

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L-Università
ta' Malta

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Declaration

I hereby declare that the presented dissertation, “Digital Interpretation Tools for Heritage” represents my own work. I have carried out myself the research, study and final project presented.

I further confirm that I have used the ideas, words, or passages of an outside source, which were quoted or paraphrased with clear and appropriate reference provided.

I also certify that this report has not exceeded the stated word limit.

Anthony Cassar

November 2019

Abstract

We are living in an age when technology is taken for granted in practically every aspect of our daily lives. Digital tools have changed the way we use memory, the way we communicate and interact with each other, how we look for and retrieve information, how we consume and purchase products and services, and the way we choose to entertain ourselves.

The cultural sector is no exception as the digital age has also had a profound effect on this sector. Technology implementation in museums requires a multidisciplinary approach, where experts in different fields need to cooperate and work together for the end result to be effective and meaningful. Effective implementation of digital tools in museums is much more than knowing the hardware specifications. The content design and the way ~~how~~ in which digital tools are used, both require a thorough understanding of museum audiences and their expectations. Bringing the various sides together to achieve a better understanding of the technology and digital tools available together with the changing realities being faced by museums today, is the main drive behind my research. My research aims to highlight the need for a multidisciplinary approach where all the different experts involved in a museum need to work together.

Throughout my research I have visited as many museums and heritage interpretation buildings as possible, both locally as well as abroad, in a bid to obtain firsthand information as to how technology is being used, if at all. In the literature review section of the research I have primarily looked at the different technology and tools available to and used by museums. I am aware that technology itself changes rapidly so although my research mentions the currently available technology, I have focused more on the rationale behind this technology and how it

should be used, to ensure that my research remains relevant even after the current technological hardware changes.

The final part of my research focuses on the upgrading of a real museum exhibit – the Albrecht Dürer collection at the Mdina Cathedral Museum in Malta. This project aims to bring together all my research into the implementation of a museum hall redesign, using a multidisciplinary team approach with a better understanding of the digital tools available for maximizing the effectiveness of a visitor's visit to the museum.

Dedication

I dedicate this thesis to my two daughters, Emma and Camille, who have accompanied me to so many museum visits in Malta and abroad. Their enthusiasm while visiting interesting and engaging, well designed museums has motivated me to aspire to see more museums, especially locally, to become more accessible, engaging and interesting to the general public.

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1. Introduction

Twenty years ago, I would patiently wait for the clock to turn 6pm, so that telephone call charges would be a flat 5c for unlimited calls, press the dialup icon and patiently wait for the model to start screeching its handshaking into the service provider's modem. Being connected to the internet meant no one else could use the telephone line and dialup speeds were excruciatingly slow. Today I conduct daily staff meetings with the programming office in Budapest via Skype, monitor the company web servers hosted in Germany and Iceland from my smart phone, and organise family holidays with my kids via google drive. We have become a truly online society. If we want to know the answer to something, we instantly Google it, if we're booking a taxi pickup, checking the weather, booking a flight or buying something, we instantly check online. When I graduated from University with an Honours degree in Marketing and Management, the web and online marketing were not even in the syllabus of any module.

I spent most of my life prior to this Masters by research working on IT driven projects as well as running my own web and multimedia company. I am also blessed with two young teenage daughters who travel as much as possible with me. I love visiting museums and they have grown accustomed to join me. I could see that museums abroad had much more to offer in interactivity and engagement than museums in Malta. My children, being digital natives, expect to find digitally driven engaging museums whenever they visit one.

Over the last eight years my company, Cyberspace Solutions, has been engaged in a number of multimedia projects for the cultural sector particularly museums. Through this experience I could see that there was a big knowledge gap between what the curators wanted and what was actually being provided. Most curators are not knowledgeable enough about the latest digital tools and their usage, whilst on the other hand the IT providers seem to have no idea of

museum practices.

1.1 Aims and Motivations

There are two main reasons why I wished to embark on this Masters by research. The first is my personal wish to see more museums engage with the widest range of visitors possible. This can be achieved through researching and investigating the latest trends and developments in museology in general, as well as specifically in the adoption of digital tools for improved visitor engagement. The other reason which inspired my research was to find out how the gap between curators and other service providers could be reduced to create more effective museum exhibits and experiences.

The definition of ‘museum’ for this dissertation is inclusive, incorporating historical sites, interpretation centres, art galleries, science centres and museums alike. All these different venues offer different informal learning experiences to the visitor. These differences influence the way different digital technologies are used. Whilst the way digital tools are used varies according to the specific venue, the underlying issues and concerns that shape the way they are applied are common throughout these different learning venues. This dissertation aims to look at issues of inclusion and accessibility, interactivity and personalization and museum learning which, taken together, are the components of a more rewarding and meaningful museum visitor experience. My research and findings consciously avoid focusing in detail on specific technologies because the rate of technological change would make any such findings obsolete within a very short period of time, probably before the completion of the dissertation itself. Instead my research and findings look at core visitor and museum issues that shape how digital tools are used within museums. These issues are much more constant than the technology itself.

1.2 Study Overview

The next section is the first part of my research, that is the '*Literature Review*', attempts to look into different influencing factors as well as new trends, digital tools and the latest methodologies aimed at creating more effective museum visitor experiences.

My review starts off with a brief analysis of the history of the Museum throughout the ages, to help understand how the role of museums has changed with changing societal needs and developments.

The literature review looks at two important components needed to frame my research. Understanding Museum Audiences and Visitors (Chapter 2.2) identifies the different visitor groups which go beyond the usual demographic and gender classifications. One of the most important roles of museums is the ability to offer an informal learning environment and the subchapter, dealing with Museum Learning (Chapter 2.3), looks at the various types of learning with a specific focus on constructivist learning. Chapter 2.4 looks at a number of the most popular and important digital tools currently implemented in museums or which offer great potential for integration into the museum visitor experience. This is not an in-depth technical review of the technology itself but rather an investigation into the potential and disadvantages of each tool when it is implemented within a museum. Wherever possible, each tool is referenced and reviewed through existing real-life case study scenarios. Digital tools offer the potential to increase museum accessibility to audiences who might otherwise have not visited the museum. This is discussed in Chapter 2.5. As part of my literature review, I set out to find out about the actual processes and methodology of designing museum experiences since this would help me

understand how best to tackle the existing gaps between curators and other service providers when designing museum experiences. These two topics are discussed in the last two sub chapters of the literature review.

Chapter 3 of this study looks into the methodology I used to collect and analyse my research data. With a focus on observation research methodologies, I had three main areas of research, these being personal artistic installations where I used digital tools to study visitor engagement, site-visits to a number of museums in various countries around Europe and finally the setting up of a number of museum digital projects which allowed me to test various concepts identified in the literature review.

As part of my research I worked on a test project focusing on improving the interpretation and visitor engagement within the Albrecht Dürer hall at the Mdina Cathedral Museum. An analysis of the findings of this project as well as my other forms of research referenced with the literature review can be found in the final chapter.

2. Literature Review

2.1 A Background to Museum Development Over the Ages

Since antiquity, mankind has always been driven to acquire and inquire about collections of objects and artefacts. By looking at the evolution of museums over the ages, one can get a better understanding of how these collections were preserved and interpreted by their audiences. This chapter aims to give a historical backdrop to the issue of the museum visitor experience being covered in the present research.

The English word “museum” is derived from Latin, yet its origins can be traced back to ancient Greece to the word *Μουσείον*, which referred to the temple where the nine Muses, daughters of Zeus and Mnemosyne, goddess of memory, lived. For the ancient Greeks Mnemosyne was a very important goddess. Through her came the ability to recall historical events and happenings, as well as the ability for powerful and persuasive rhetoric. Memories were orally passed on from one generation to the next through the knowledge embodied by the muses, especially myths, music, poetry and lyrical songs. This was especially important at a time when for centuries memories were passed orally before writing could be used to record events (Lee, 1997).

The word itself implies a building which is home to the arts and a place of study (Walker, 2015). The famous Ptolemaic library of Alexandria, built close to Alexander the Great’s tomb, was part of a bigger complex called a *mousaion* or shrine of the muses (Murray, S. A., 2009). Situated in Bruchion, the large building of the museum was purposely designed for scholars to be able to converse about and discuss matters related to literature. The building was created to

proclaim the magnificence of the Ptolemies and their love for the protection of Letters. The Alexandrian museum had four main functions; to act as a temple or palace for the muses, to be an ongoing project of knowledge and scholarship, to provide an example of enlightened *civitas* that could be copied by the citizens of Alexandria and finally, to make a symbolic political statement which placed the museum, the ultimate collector of knowledge about everything and everyone, in the very centre of the ~~centre of the~~ Hellenistic world.

Although the *Musaeum* of Alexandria ceased to exist since around the 4th century C.E., it is truly extraordinary how its reputation survived the millennia. Without any physical remains to discover or rebuild, the word *mousaion* retained the glory and importance of the Alexandrian institution it once was.

Between the 16th and 18th century, in Italy, the Latin word *musaeum* began to be more associated with physical buildings such as temple, study, gallery or library. In France *musaeum* was often exclusively understood to refer to the collection of scholars studying the arts, letters and sciences within the *Musaeum* of Alexandria (Lee, P. Y., 1997). This has led to the word *museum* assuming two primary meanings: an institution for the collection and preservation of knowledge as well as a specific type of architectural building. Throughout the 17th and 18th century scholars have tried hard to research all they could about the Musaeum of Alexandria. This research was meant to help them understand its functions and operations as well as its architectural design, both of which played important roles in the design of modern museums. Prior to the establishment of the first public museums, many other terms were used including, ‘Cabinet’, ‘Kunst-Kamer’, ‘Study’ and ‘Library’.

The modern use of the word museum as a collection of artefacts can be traced back to Revolutionary France when in 1793, the collections found at the *Cabinet du Roi* and the *Cabinet*

d'Historie Naturelle were declared the property of the people and no longer belonged to the King (Lee, 1997). A lengthy and detailed brief for the design of a museum in 1779 by the Academie des BeauxArts, defined a 'museum' as being very similar to the ancient Alexandrian museum. It was meant to include a garden for public walks, rooms for the preservation of natural history, science, military and art collections, a library and built entirely of stone like the city of Alexandria. The museum was also meant to act as a research centre attracting scholars in order to focus on different areas of specialization.

Modern museums sorting digital artefacts and making use of all multimedia and all forms of digital tools to enhance the visitor experience seem to once again emulate the ancient temple where the muses lived, taking once again the true meaning of museums closer to its original meaning (Graves, 2017).

Understanding the origins of the word "museum", its link to the ancient museum and how it was used and adopted in modern times will help us understand the perceived role that museums are expected to play in a modern society. As Kenneth Hudson (1977a) once said, "what a museum is trying to achieve is more important than what it is" (p78). The 'Museum' continues to evolve and reinvent itself shaped by the many societal forces in which it exists; it refuses to stand still (Lee, 1997).

The earliest form of an interpreted collection of ancient objects was traced to the city of Larsa, a prominent Summarian city in Mesopotamia. When British archaeologist Sir Leonard Woolley was excavating the 6th century B.C.E. level of the ancient City of Ur, he unearthed a significant collection of artefacts from different times and places, neatly organised and some were even labeled. Woolley discovered a tablet referring to 21st Century B.C.E. artefacts. It is thought that this tablet was indeed a museum label. He found evidence that the Babylonian kings

Nebuchadrezzar and Nabonidus had amassed collections of antiquity. Nabonidus' daughter, Princess Ennigaldi was a priestess who ran an educational museum within her own temple school (Hudson, 1977b).

Bigger collections of artistic objects can be traced back to the Classical age. Votive offerings found in temples during the times of the Greek and Roman empires are a clear testament to this. These would have included many wonders, trinkets, as well as artistic products that would be available to the view of the public upon payment of a fee. The earliest clear connotations of the idea of a museum are to be found within ancient Greece, with the introduction of the *pinakotheke*, (Woolley, 2009) an art gallery such as the one found on the Acropolis in Athens.

Artworks were to be found in many a public place in Rome, though the concept of a museum had not yet come to fruition. Many, most notably Agrippa, a deputy of the Emperor Augustus, opined that the collections of the Roman Emperors should be open to the public, (The Propylaia, n.d.). When in 189 B.C.E. the famous Roman General Marcus Fulvius Nobilior returned to Rome, after a successful campaign in northern Greece, he constructed a temple dedicated to Hercules, leader / friend of the Muses. In this temple he placed on display the treasure he had brought back with him made up of thousands of gold and silver artefacts as well as statues (Powell, 2015). In ancient Rome, Museums and libraries flourished, the City of Cities was filled with art and treasures from Greece and Egypt. Whilst the libraries have been lost with time, our museums are full of treasures which once filled the Roman ones.

Asian culture seems to have grasped the concept of museums a bit earlier than that of their European counterparts. Traces of collections in Asia can be found within the remnants of the Shang dynasty, (Ripley, 1978) which ruled China for five centuries, from the 16th to the

11th centuries B.C.E. The infamous terracotta warriors, found guarding the grave of the Ch'in Emperor Shih Huang-ti, are a clear indication that by the third century B.C.E., the concept was already prominent. The same emperor's palace is known to have housed many rare and valuable collectibles.

Around the 8th century AD, the Todai Temple of Japan was built to house the magnificent bronze statue of the Great Buddha. The Shoso-in repository still houses/contains the temple's collection, hundreds of items donated by Empress Kōmyō to express her love for her dead husband Emperor Shōmu (Princeton University, 2004).

Medieval times are characterized by the huge divide between social classes. Collections were practically owned by the nobility or the church. The Roman Catholic Church led and dominated intellectual thinking in Europe. Monasteries became centres of learning, and amassed considerable manuscript libraries and hand printed books, relics and all sorts of gifts and treasures. The trade in Christian relics was rife during this period. At the same time trade in antiquity can be traced as far back as the 12th century. The Bishop of Winchester, Henry of Blois, purchased a collection of ancient statues whilst visiting Rome and had them shipped back to England (Murray, D., 1904). Pope Sixtus IV was a great patron of the arts. He employed many leading artists including Botticelli for the beautification of the Sistine chapel (named after him), but his most important contribution was the building of a new Vatican library. By the end of the 15th century, the Pope had collected a significant collection of works of art (Weiss, 1969).

The Renaissance created a renewed interest in Italy's classic heritage. This was a time when new trade routes were developed and a new banking system established. This economic boost saw the emergence of new rich and powerful families. To demonstrate their power these

families prided themselves on building impressive collections of antiquities, and offering their patronage to some of the most talented artists in Italy.

The Medici rulers of the city of Florence exerted a major influence on the growth of the Italian Renaissance. They built a huge collection of valuable decorative artistic objects which included jewellery, precious vessels, *pietre dure* reliquaries, sculptures, goldsmithing, tapestries and paintings. This collection, started by Cosimo I de' Medici and further enriched by his sons and successors, was passed on to the state in 1743 to be made accessible to the public. The collection of Medici paintings was housed in the upper floors of the Uffizi Palace, previously the offices of the administrative and judiciary offices of Florence. The collection was opened to the public in 1582 (Ripley, 1978).

Royal families around Europe started amassing their own collections. Notable amongst these was King Matthias I of Hungary, a collector of paintings and Roman antiquities. His royal Library, the Bibliotheca Corviniana, was one of the most renowned and biggest in Europe (Massinelli, et al., 1992).

In the Renaissance, the past once again became a refuge as artists turned to it for inspiration. From the late Renaissance period onwards, museums developed in two directions – art and history museums focusing primarily on the appreciation of the classical world, and science museums focusing on discoveries (Csapodi, 1969).

The period between the latter part of the 17th century and the beginning of the 19th, known as the Enlightenment, brought radical changes to European science, politics and philosophy. Enlightenment thinkers believed that humanity could be improved through reason, logic and freedom of thought. Enlightenment ideals directly instigated the American and French revolutions (Carbonell, 2004).

The “Ashmolean Museum of Art and Archaeology” is the oldest public museum. Opened in 1683, by the University of Oxford, the museum houses a huge collection bequeathed by Elias Ashmole in 1677. Over the years the original natural history collections grew to also include priceless collections of Egyptian and Renaissance art. The original building which housed the Ashmolean Museum is today’s Museum of the History of Science (Burnett, Sloan, & Museum British, 2003), The Enlightenment was fuelled by an encyclopedic spirit, increased world exploration and industrialisation. These influencers can be seen in the opening of two very important museums at the time, the British Museum in London in 1759 and the Louvre Museum in Paris in 1793.

The British Museum was set up specifically as a result of the UK Government to group together three separate collections. The collections, belonging to Sir Robert Cotton, Sir Hans Sloane and Robert Harley, contained thousands of artefacts including manuscripts, numismatics, art, curiosities and specimens from natural history. The 1753 Act of Parliament, known as the British Museum Act 1753, specifically stated that the British Museum’s collections were “to be preserved and maintained not only for the Inspection and Entertainment of the learned and the curious, but for the general Use and Benefit of the Public” (Edwards, 1870, p.305). Entrance to the British Museum was always free, although originally there was a daily capping on the number of visitors allowed. When the museum was initially opened it attracted more than 5,000 visitors a year, annual figures for the museum have since risen to around 8 million a year (Ovenell, 1986).

The Central Museum of the Arts was opened in Paris by the Revolutionary Government in 1793. The museum was not fully accessible to the public before 1801. The Louvre collection grew rapidly, mostly due to the exploits of Napoleon who was instructed to appropriate as many

works of art as he could during the European Campaigns. This resulted in many royal and noble collections finding their way to Paris (British Museum, 2017).

During this period the huge collections at the Vatican underwent a complete reorganization. In 1734, the Capitoline Museum was opened to the public, as was a picture gallery collection housed in the Palazzo dei Conservatori. In 1772 the Pio-Clementino Museum, founded by Pope Clement and housing a huge collection of antiquities, was opened to the public in the Vatican City.

Other important museums which were made accessible to the public during this period included Madrid's Prado Museum, Berlin's picture Gallery which continued to grow into what is now Museum Island, the Hermitage in Saint Petersburg displaying artworks from the Tsars' collections, the Royal Museums in Brussels and the national art gallery in Amsterdam which was later to become the Rijksmuseum. By the end of the 18th Century the European model of the museum started spreading worldwide, especially in America and along the colonial routes. The 19th century saw Museums in the same way as other institutions of high culture, viewed by city planners as a means of civilising the masses. In Victorian England, James Silk Buckingham was one of the first to include culture as a way of reforming the politics of the time. Just as well laid, clean town layouts improved the health and wellbeing of citizens so did museums, libraries and art galleries. Museums suddenly found themselves entangled in the process of governing citizens, by being engaged to help shape and influence society's moral, mental and behavioral characteristics (McClellan, 1994).

Towards the second half of the 19th century there was a proliferation of museums in Europe. This growth was fueled mainly by the introduction of compulsory free education by the state as well as by a strong sense of national pride. In just 15 years more than a hundred

museums opened in Britain and around fifty museums were set up in Germany in just 5 years (1876-1880). Museums in this period started to innovate also with regards to presentation and interpretation. England's Liverpool Museum was one of the first to use Panoramas to improve interpretation. With the introduction of Gas and later Electricity, museums could now also start offering longer opening hours allowing people who would not normally be able to attend the museum during the day to do so after-hours.

The cataclysmic events of two world wars had a profound effect on the way people looked at their nation's past as a way of defining their identity (Bennett, 1995). In his book *The Representation of the Past*, Kevin Walsh explains how legislation relating to cultural heritage preservation and management in the UK underwent significant changes after the end of World War II. The 1960s saw the establishment of pressure groups aimed at preserving and protecting cultural heritage, the publication of a new generation of heritage magazines as well as a more market driven approach by museums.

In the UK, the 70s and 80 are often referred to as the 'heritage boom' as they saw the setting up of many open-air museums, as well as many indoor cultural heritage sites using new multimedia multisensory technologies to enhance visitor interpretation. Some of the established museums also chose to start experimenting with some of these technologies in their visitor experience. This was the beginning of the departure from the traditional orthodox museum experience. Open-air and folk-life museums were first established in Scandinavia, in the late 19th century. These provided a popular way of understanding the past by bringing it back to life. The successes of open-air museums such as Greenfield and Williamsburg may have helped prompt Disney to open their first Disneyland in 1955. Heritage sites started recreating historical events, allowing visitors to experience first-hand the historical period or event of the time.

Heritage centres can be considered as very close relatives of museums. They attempt to recreate history through the use of interpretative multimedia technology. These centres often focus on one theme emphasizing spectacle rather than education. One such heritage centre was “Royal Britain” established next to the Barbican in central London. The patriotic narrative of Royal Britain, featuring the life and exploits of British monarchs, used various multimedia effects such as reconstructions, projections, lighting effects and life-size representations of Royals. Another Heritage experience worth mentioning is the Oxford Story, meant to recreate the illustrious history of Oxford University. The visitor is taken on a journey through time via a series of exhibits meant to illustrate the University’s history,

During the 1980s and the early 1990s some museums reacted to the success of heritage, and the need to survive in the market-place, by mimicking the heritage spectacle, rather than attempting to provide a service that sets the museum apart from the all too common multi-media experience (Marwick, 1990).

The Imperial War Museum, London, was one of the first to integrate historical reenactment into its displays, through two shows ‘Blitz Experience’ opened in 1989, and ‘Trench Experience’ opened in 1990. Whilst both shows, with their special effects, were extremely entertaining to visitors, it was highly unlikely that the thousands of visitors who visited them learnt much about the horrors of war. Museums discovering the use of special effects and multimedia had to learn that the museum experience needed to go beyond the showman effect to enrich the visitor experience.

‘New Museology’ is a term that refers to a new approach in museum practice that developed in the early 1980s. It was the result of the rejection of the traditional role of museums

in society. In the 1970s, a general feeling of detachment from the modern world was attributed to museums which were in a way considered to be outdated and obsolete. Some went as far as to say that they had become a waste of public funds (Walsh, 2002). Museums were completely focused around collections, with the curatorial role having absolute authority on the museum. Traditional museology was thus considered elitist, reflecting only the tastes of a select societal group.

One very interesting definition of this new contemporary approach is given by Peter Vergo (1989) in his book 'New Museology' where he states that;

At the simplest level I would define it, as a state of widespread dissatisfaction with the 'old' museology, both within and outside the museum profession; and though the reader may object that such a definition is not merely negative, but circular, I would retort that what is wrong with the 'old' museology is that it is too much about museum methods, and too little about purposes of museums; that museology has in the past only frequently been seen, if it has been seen at all, as a theoretical and humanistic discipline. (p.3.)

As a result, this new contemporary approach in museology was meant to introduce a new philosophy and approach to the relationship between society and communities vis-a-vis museums. A new style of communication and expression away from collections-focused models was introduced, (Vergo, 1989). This new philosophy rethinks the relationship that museums have with communities, thus striving for wider access and representation (Mairesse & Desvallées, 2010). In this new contemporary approach in museology the public's role is widened from that of a simple visitor to one with the ability to control the curatorial function, (Black, 2012).

Understanding the evolution of museums and the role they play to preserve and interpret history, as well as their evolution from shapers of society to partners of communities, would help

us understand better the relevance of museums today and in the future. Current technology offers us powerful digital tools to better understand and interpret the artefacts presented by museums.

Yet, these tools will only be as effective as our ability to implement them after we understand the public's expectations of the role of museums in our times.

2.2 Museum Audiences and the Visitor Experience

As John Falk points out, visitors are at the heart of the modern museum (Stam, 1993). Without visitors' museums will fail, and, therefore, understanding them is crucial for the museums' survival. As a result, museums are actively seeking to gain a better understanding of their existing and potential visitors. The issues being studied are what motivates them to visit museums, their needs and expectations as well as the reasons why some people refuse to visit at all (Falk, John H., 2009) .

The first part of this chapter looks at some of the more important visitor studies and theories which are shaping current museum approaches to understanding and retaining their existing visitors. The second part of the chapter aims to discuss audience development strategies.

2.2.1 Museum Visitor Studies

Since the 1970s visitor studies have become an important research area for museums and a number of organisations dedicated to such studies have been established across the western world. A comprehensive overview of the development of museum studies can be found in J.R Loomis's book *Museum Visitor Evaluation: New Tool for Management* (Goldman, Schaller, & Adventures, 2004a). It is estimated that museum visitors around the world pay more than one billion visits to museums annually (Loomis, 1987). Understanding what motivates these people to visit museums rather than engage in some other entertaining activity will help museums understand better their audiences and the visitor experience that should be offered. Equally important is the understanding of why many more people refuse to visit museums.

The visitor experience is vital to ensure the sustainability of museums. Before, the visitor experience was considered as a luxury add-on to what the museum offered. With the advent of this new approach in museology it now lies in the very centre of the museum's existence. Museums have stopped focusing inward into their collection and are now looking outwards towards their visitors (Falk et al., 2016b). Before, the curator had the ultimate authority to decide what should be presented and what was interesting or not for the visitor. Now it has become crucial for museums to find out what visitors want and how to deliver it to them. The traditional gender and demographic analysis of visitors is not effective enough to really understand who the museum visitors are. People visit museums for personal reasons and not just as a result of their gender or because they come from a majority or minority part of the population. Although these personal reasons are also related to gender and ethnicity, they are very much influenced by the person's leisure choices (Vergo, 1989).

The success of any retail product depends on giving customers a product which they need and in a way that is acceptable for them to enjoy. The same can be said for museums. In order to try to understand what motivates the public to visit museums, current research focuses on extensive interviews with museum visitors. After analyzing these interviews, researchers can categorize visitors into groups. One example of such an approach can be seen in the research entitled *Family Agendas and Family Learning in Hands-on Museums* that Theano Moussouri carried out in the UK. Moussouri (1997) came up with six categories which included; Education, Entertainment, Social Event, Lifecycle, Place and Practical issues. In a bid to better understand what motivated visitors to visit the different Smithsonian museums, researcher Zahava Doering (1999) and her team categorized visitor experiences into four different categories: Object experiences, Cognitive experiences, Introspective experiences and Social Experiences . Another

research carried out by Jan Packer in Australia involved looking at the experiences of 300 visitors at a history museum, an art gallery and an aquarium. Instead of just focusing on the motivation for visiting the venue, visitors were asked to rate the expected outcomes of such a visit. An analysis of these outcomes subdivides motivations into 5 categories; Learning and Discovery, Passive Enjoyment, Restoration, Social Interaction and Self-fulfilment (Pekarik et al., 1999). Regardless of the model used, it is clear that people visit museums for a wide variety of reasons and there are many similarities across these different models.

The more we understand what is expected from the visitor experience the more can museum professionals design experiences that will positively affect people's lives. The visitor experience is much more complex than what happens in the confines of the museum building. Personal motivation, individual and group identity are all important shapers of the visitor experience. Building on his vast experience with studying museum visitors, John Falk devised a predictive model of the visitor experience. This is important because it can help the museum meet visitors' needs and expectations. Falk's theory moves away from categorizing visitors by the traditional audience groups such as occupation and demographics, which is what most museums currently rely on to predict visitors to their institutions. In his book *Identity and the Museum Visitor Experience* he creates a preemptive model of identifying and classifying museum visitors according to their identities and their motivations for visiting a museum (Packer & Ballantyne, 2002).

Based on hundreds of interviews of people visiting the *California Science Center*, Falk classified these visitors into 5 main groupings related to different types of leisure benefits perceived to be achieved by visitors; Explorers, Facilitators, Experience Seekers, Professionals

and Rechargers. A detailed description of these visitor types can be found in the appendix APP2.2c.

Falk firmly believes that the one size fits all mass produced model does not fit the museums of the 21st Century. Today's knowledge society is characterized by personalized information retrieval and personalized visitor experiences. The book "Identity and the museum experience" stresses that every visitor is different with varying needs and interests. One characteristic that is, however, common in every visitor motivational category is learning, be it explicit or implicit, (Falk, 2016). Every visitor to a museum expects to learn something making such a visit different from visits to other venues such as theme parks. Although museums offer many benefits related to leisure, the most dominant aspect of the museum visit is learning. Aspects of museum learning are discussed in Chapter 3 of this literature review.

Falk examines the relationship between perceived personal needs and what the museums have to offer. The dialogic feedback loop starts when the public begins looking for leisure options and experiences that meet personal identify related needs, such as better parenting or personal enrichment. The public has come to perceive museums as venues for meeting some of these personal needs. Once the visitors are inside the museum, they will use the visit to fit their predetermined, specific and expected needs. Once they leave, they will decide the outcome of the visit according to how much the museum has been able to satisfy their needs. The better the fit between their personal needs and the way the museum visit satisfied those needs and expectations, the more satisfying the experience. As time passes, visitors will look back at their visit's experience through the personal motivators that were used to judge the visit, and share with others their experience of the visit. When the same personal need arises once again in the future, these visitors will revisit the museum or similar sites that can meet these needs (Falk,

John, 2016). Just like any feedback loops this process reinforces itself not only from an individual's point of view but also for society in general.

Each museum attracts different kinds of visitors with different generic and personal needs and expectations. Given that already very different individuals with completely different motivations are visiting the same museum, it can be safely said that museums are already managing to somehow meet some of these completely different needs, even if unintentionally so. Falk cautions museums not to design their museum setup to meet just a one time audience, and this is because the same visitor may have different needs on different days / visits. Since visit motivations are fluid and shaped by personal needs and contexts, the best museums are those that can offer different types of experiences within the same setup.

By understanding the *Falk Visitor Experience Model* museums can start making necessary changes to be more in line with the needs and expectations of their visitors. Understanding the people who refuse to visit museums (nonparticipants) is also a very useful exercise in potentially identifying those areas that the museum can change or improve in order to attract these people (Falk, 2016) . Museum professionals often struggle to understand how it is possible that notwithstanding all the treasures and priceless works of art and artefacts found in museums, people still refuse to visit. Whilst various forms of research such as time tracking, visitor patterns, interviews and time-lapse photography have been used to understand museum visitors, this has not shed light on why the majority of the public still do not visit museums. In a very interesting article published in the Museum News and entitled *Staying Away, Why People Choose Not To Visit Museums* , Marilyn G. Hood (2004) states that visitor demographic analysis is not enough to understand why individuals choose to visit a museum or not. The focus should be on how visitors choose to spend their leisure time and what motivates them to choose one

venue over another. Different venues are competing with each other to attract visitors, and visitors will choose to attend those venues which give them the highest rewards and satisfaction on how they spend their leisure time. Understanding these perceived returns would identify how visitors assign opportunity cost when deciding to visit a museum or another leisure activity or venue (Liu, 2013).

Based on extensive multidisciplinary studies and research in fields such as museology, psychology, sociology and consumer behavior, six main attributes determining adult choices as to how they spend their leisure time have been identified. The six categories identified by Hood (1991) are (1) being with people, or social interaction (2) doing something worthwhile (3) feeling comfortable and at ease in one's surroundings (4) having a challenge of new experiences (5) having an opportunity to learn and participating actively.

In his book *The Engaging Museum* Graham Black looks at specific category grouping of visitors – Families and Children (Hood, 1983). Black suggests that, since this grouping of visitors is significant for museums, having child-friendly/appropriate displays is essential for museums. Children have specific requirements which might be quite different from those of adults. From a very young age children are exposed to all forms of technology for their entertainment and thus they have a predisposition for exhibits which are more tech savvy such as interactive exhibits, digital tools and creative activities. Children have a tendency to get easily bored unless the visit is engaging and appeals to them. They love to dress up, to participate and feel involved. Children who visited a museum as part of a school trip are likely to return to share the experience with their family.

The USA Visitor Services association identified a list of human needs as seen from the visitors' point of view. This list of 11 basic needs is called the "Visitors' Bill of Rights" and

includes: “Comfort, Orientation, Welcome/Belonging, Enjoyment, Socialising, Respect, Communication, Learning, Choice and Control, Challenges and Confidence Revitalization” (Rand, 2004, pp.158-159). Maslow’s hierarchy of needs can be used to further explore visitors’ needs (Black, 2012). An explanation of how this hierarchy has been applied for museums can be found in the appendix APP2.2b. Since Maslow’s publication of the hierarchy of needs, further improvements and refinements have been made to the above list. These included the development of cognitive and aesthetic needs all of which can be used by museums to better understand what visitors expect.

2.2.2 Audience Development

Museums are under constant pressure to expand access to their collections. Attracting more visitors to museums would make the latter more sustainable and would help them justify requests for funding and assistance. Social and political changes pressure museums to create new audiences that go beyond the traditional middle class of frequent visitors and occasional participants. Pressure is mounting from ethnic and disability lobby groups who feel excluded from inaccessible heritage sites and museums.

Audience development is not simply getting more of the museum’s existing visitors. NEMO – the network of European Museum Organizations describes Audience development as a tool to allow “museums to better reach current and potential visitors by more effectively meeting their needs and expectations and by developing stronger on-going relationships with the audience.” (the Network of European Museum Organizations NEMO, 2019)

Audience development refers to the process of retaining existing museum visitors ensuring they become repeat visitors as well as attracting new museum audiences. Audience development brings together the various departments of the museum including curatorial, educational and visitor services. In today's visitor centred museums, following contemporary \ museology trends, Audience development becomes the most important role within the museum.

Audience development is an organization-wide effort and requires all the different players including senior management, curators, museum staff, as well as marketing and education teams to be onboard. In a report published by the UK Lottery Heritage Fund (2010), entitled *Thinking about... Audience Development*, the following under-represented groups in museum audiences were identified. "older people; young people; families; people with lower educational attainment; people from black, Asian and minority ethnic communities; disabled people; and people in lower socio-economic groups and on low incomes" (p.7). The report, meant as a guidebook for not-for-profit organizations operating in the cultural sector and wishing to apply for funding from the Heritage Lottery Fund, offers a 5-step guide for Audience development that is recommended for museums.

Another resource for Audience development, which is similar in structure, is the "Audience Development tool kit". This was developed by the British Council for the Project "Transforming Future Museums: International Museum Academy Greece" and aims to offer museum professionals participating in this course practical tools and knowledge to develop audiences in their own museums. It includes a number of case studies, models and resources which can be applied to any museum (British Council and IMA & Sarah Boiling i, 2016).

The book *Museum Basics* highlights a number of practical initiatives to help museums grow their audiences. Museums are not meant to solve all the problems in the world but they must ensure they do their part to carry out Article 27 of the Universal Declaration of Human Rights which states that “everyone has the right to participate in the cultural life of the community to enjoy the arts and to share in scientific advancement and its benefits” (Ambrose & Paine, 2018). Falk (2009) says that helping potential visitors realize that the museum can meet and satisfy their individual needs is the secret to attracting and building audiences. The museum’s audience development efforts must ensure that audiences with special needs and disabilities, disadvantaged groups, minorities or marginalized groups feel welcome and have equal access to the museum.

2.3 Museum Learning

Museum Education has always been recognized as one of the most crucial public museum functions. As discussed in Section 2.1 public museums grew in line with the need to expand knowledge beyond the select few. Public museums developed at the same time as freely available public schooling became mandatory in industrialized nations. Yet although public schooling developed its own structured systems of assessing knowledge acquisition, museums retained a more open attitude towards learning by assuming that the public would be enlightened and entertained through their visits to museums but without in-depth consideration and studies of the visitors' experience. Over the last four decades museums have seen a shift in their definition of education and its relevance within the museum sector. This has been a result of society's changing social and cultural structure. As Hein (2002) explains, 'Learning is now seen as an active participation of the learner with the environment' (p.6).

The concept that museums were not only exhibition areas but also a place of learning was already present in the setup of museums in the late 19th and early 20th century. This can be seen in Benjamin Ives Gilman's book *Museum Ideals of Purpose and Method* (1918)

To fulfil its complete purpose as a show, a museum must do the needful in both ways. It must arrange its contents so that they can be looked at, but also help its average of visitors to know what they mean. It must at once install its contents and see to their interpretation. (p.280)

Over the rest of the 20th century, the primary emphasis shifted mainly to collecting with learning taking a secondary role. However, in the last few decades, museum learning has seen a significant revival and has become once again a primary function of museums. Since the late

1960s, numerous reports and studies have been prepared on the subject of lifelong learning and the role of museums in the learning age. Primary amongst these are: “America’s Museums, *The Belmont Report* (USA 1969), *Musées, Imagination and education* (UNESCO, 1973), *Museums for a New Century* (USA, 1984), *A Common Wealth; Museums in the learning age* (UK, 1997).

The globalized economy, the fact that jobs are no longer for life, and advances in technology have brought about radical changes in job and career patterns. Lifelong learning has become part of the political agenda in the western world and considered as a key to enable the workforce to become more flexible and better able to adapt to these changes.

A landmark report published by the American Association of Museums (1992) entitled *Excellence and Equity* emphasizes the contributions that Museums offer towards a nation’s educational needs. Education is a core role of the museum’s services to the public. The report describes museums as institutions of public service and education, a term that includes exploration, study observation, critical thinking, contemplation, and dialogue. (American Association of Museums, 1992) *Excellence and Equity* helps museums understand how effective they are being in executing their educational role and thus serving the public. Being public institutions, museums must ensure that they achieve the highest level of inclusiveness. The museum, including its employees and volunteers, should ensure that it respects the rich mix and diversity in gender, economic status, race, education and race among museum visitors and reflect such a mix in its programmes.

Following the New Labour’s return to power in the UK, Tony Blair’s government channeled significant funding towards education and social inclusion initiatives. An official government policy for museums in the UK stated that lifelong learning had to become a core function of museums, (Black, 2012). This can be considered a significant development as lifelong

learning was no longer associated with new skill sets for employment, but as a means of achieving Maslow's ultimate aim of self-actualization. In a report prepared for the UK's Department for Media, Culture and Sport in 2012, Darren Henley (2012) emphasizes the many learning opportunities that heritage learning can offer not only to young people's personal development, new skills and knowledge acquisition but to society as a whole (Henley, 2012). Following this report, the government adopted a number of recommendations found in the report including a plan for cultural education in England.

In a White Paper published by the European Commission in 1994, lifelong learning was seen as a form of competitive advantage to the employment threats brought about by globalization and technology developments. The European Commission declared 1996 as the *European Year of Life Long Learning* during which year, many measures and actions were launched to promote and create awareness on the importance of lifelong learning. Since then many common policies, funding programmes and initiatives have been introduced by the EU to encourage lifelong learning.

Learning, "... is not just an accumulation of skills and information, but a process of becoming – to become a certain person or conversely to avoid becoming a certain person" (Wenger, 1999, p.215) [OEB]. Humans are learning creatures and learning is now considered a basic human attribute. Learning is a continuous, natural process and not always purposeful or specifically educational. In life we often learn without intending to. Learning is not limited to the intellect but also involves emotions and expression. According to Hopper-Greenhill (2007), "If culture is understood as a process of signification, a means of producing meaning that shapes world views, then learning in museums and other cultural organizations is potentially dynamic and profound, producing self-identities"(p.9).

The process of learning is both about **how** we learn (the process) and **what** we learn (the outcomes). In his book *Learning in the Museum* George E. Hein (2002) compares different theories of knowledge, in particular Realism, Idealism and the classic Platonic approach (Hein, 2002).

The traditional museum exhibition was meant to educate the visitor. Taking a realist's approach to knowledge, the curator seeks to transfer knowledge from himself to the student/visitor, through digestible small bite sized morsels of information presented via labels or graphic panels. From the visitors' point of view this is a very passive approach. This didactic based knowledge transfer approach conveniently fits the institutional framework of most museums and their collections. The way museum curator and visitor dynamic has worked for so many years reinforces this way of transmitting knowledge. The curator appointed to his post after many years of formal education is there to teach, often in a way similar to how he himself had learned. The visitor is also part of the issue. In fact, the higher the education of the visitor, the higher his chances of visiting museums more often, and also the higher the chance that the visitor accepts this kind of didactic information transfer since it has been part of his own formal education. Of their very nature museum exhibitions are designed for mass audiences. They cater for similar groups of visitors with similar interests and understanding. The more visitors start looking for individual experiences, the more will museums have to move away from a one size fits all approach. Traditional exhibitions are similar to text books, whose contents follow a logical and paced structure, starting with an introduction, and moving on to development and conclusion. Like a text book they are the perfect way to absorb information correctly and passively. A different form of this learning process is where students need to engage, do and

experience rather than simply be told, thus allowing them to acquire and apply knowledge in an ongoing rather than one off process. This becomes a lifelong process of knowledge acquisition and development of understanding. Every visit to a museum has the potential to become a learning opportunity.

Educational theory can be classified in two: the knowledge theory and the learning theory. Each of these two theories has extremes. On one end of 'the theory of knowledge' as proposed by Plato, knowledge is attributed to forms independent of the learner whilst on the other end is British philosopher George Berkley's idea, that knowledge exists only in the mind of the knower. The second aspect of the educational theory is related to how people learn. One extreme in the theory of learning is that proposed by Locke which says that learning happens as an incremental process building onto a tabula rasa whilst on the other end is Piaget's idea that learning is constructed. Constructivism combines the way knowledge is constructed and the way it is obtained in the person's mind.

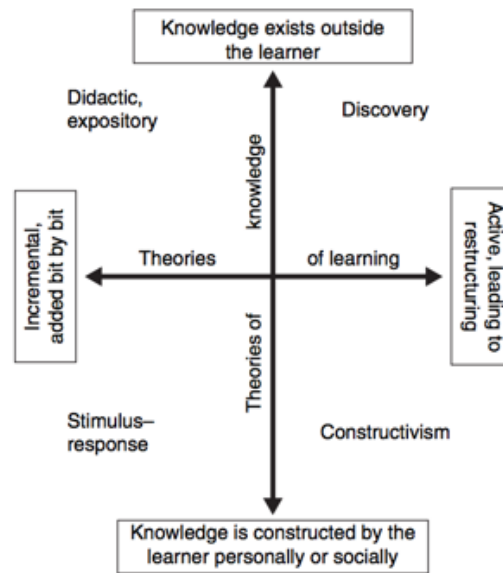


Figure 2.3.1 Theories of education – (Macdonald, S., 2006)

As Hein explains, the wide range of museum audiences with their diverse expectations and backgrounds makes constructivism particularly appropriate when developing museum education as a way to facilitate learning from museum experiences during audiences' short and voluntary visits to museums.

In recent years, the emphasis in museums has shifted from education, which is more formal, passive and directed towards students, to learning which is targeted at people of all ages. Hein uses the term Free-Choice learning, a term also suggested by Lynn D. Dierking and John Falk to describe the type of learning that takes place in a museum. This type of learning has unique characteristics, being free-choice, non-sequential, self-paced and voluntary (Falk, 2005). The "Constructivist" theory of constructing knowledge by the visitor replaces the older "Positivist" theory, which believes that knowledge is available, waiting to be obtained (Ambrose & Paine, 2018).

Many theories have been proposed and developed as to how people (especially children) learn. Museums have adopted some of these theories in the way they design their exhibitions and in the learning programmes they offer. The ‘Behaviorist’ approach postulates that practice and experience are what shape behaviour. The ‘Cognitive-developmental’ approach believes that a child can only learn through active exchange happening between the learner and the museum. According to the ‘Discovery learning’ theory, learning occurs when learners discover facts for themselves. This enquiry-based, constructivist theory has three different modes enactive, iconic, and symbolic – refer to the case study Symbol Literacy Project at the end of this chapter. The ‘Multiple Intelligence’ theory suggests that humans use all or some of the following intelligences to be able to learn (Linguistic, Musical, Logical, Visual/special, Tactile/physical, Interpersonal, Intrapersonal, Intuitive, and Creative). ‘Social cognition’ states that it is society that shapes what and how children think. ‘Constructivism’ believes that learners construct their own knowledge, with meaning being created through learning. Play is considered to be crucial to a child’s development as it allows children to learn how to be inquisitive and imaginative, tackle problems, role play and create meaning around events and objects. “The Symbol Literacy” (Gellel, 2018) gives a clear example of how play is being used within the Mdina Cathedral Museum to encourage the teaching of symbolism in art to young children – please refer to case study 2.3.1 in Appendix. Another interesting area of research is how museums can change or build on the previous knowledge and understanding that any visitor brings with him to the museum (Ambrose & Paine, 2018) Learning theories mentioned above seem to be more focused on children, the theory of Andragogy by Malcolm Knowles differentiates adults’ learning from the way children learn (Knowles et al., 2012).

Adults learn in a way different from how children learn. Museums have a tendency to focus more on learning for children rather than for adults, assuming that adults will automatically like and use whatever is prepared for children. Tilden (1997) states that museum interpretation for adults should be different from that for children. Falk says that visitors will bring with them prior life skills, knowledge, experience, emotions and independent thought as well as different motivations for learning (Falk, John H., 1999). Adults will also face different barriers to learning from children.

Since motivation is a key determining factor in lifelong and life-wide learning, understanding what motivates visitors to visit museums and the effect this has on learning becomes very important. Falk identifies six categories of motivation: ‘place, education, life cycle, social event, environment and practical uses’ as well as 3 types of visits settings: unfocused, moderately focused and focused. Different audiences (and non-visitors) have different expectations of their visit to a museum. Understanding motivation is key to retaining existing audiences and attracting new ones. Museums have to rethink their image to ensure this.

The Learning Impact Research Project (LIRP), part of a larger research project, developed a framework of five generic learning Outcomes (GLOs); i. Knowledge and understanding, ii. Skills, iii. Attitudes and values, iv. Enjoyment, inspiration and creativity and v. Activity, behavior and progression. This framework was tested on 15 different museums, libraries and archives, to show the GLOs could be used to measure learning throughout this sector. A detailed overview of this framework can be found in the Appendix APP2.3.1

Museum learning is not simply the acquisition of knowledge and facts but should include emotions such as pleasure, awe or inspiration that are what visitor experiences are made of. Inspiration, amazement and enjoyment can in-turn provide the necessary motivation to acquire

knowledge and facts. Learning becomes a “lifelong process of making meaning” and not simply a result of scholarship (Falk, John H., 1998) . Both individual as well as social learning becomes a process of identity building. Learning outcomes have been developed on the above learning theory.

Global Learning Outcomes have since been used in a large number of cultural heritage settings, particularly museums, to try to structure and measure learning within formal learning environments but they are also gaining popularity in free-choice informal learning environments, though the latter still provides significant measurement challenges.

The Constructivist Museum - “Constructivist educational theory argues that in any discussion of teaching and learning the focus needs to be on the learner, not on the subject to be learned.”(Hooper-Greenhill et al., 2003, p.78)

For museums this is a very important game changer where the exhibitions should not focus on the artefacts but on the visitor. In his book *Learning in the Museum*, Hein (2002) discusses the idea of the museum built completely around constructivist principles. If museums were to accept the principle that “Visitors make meaning in the museum, they learn by constructing their own understanding “Formatting... please wait (p.179), then their role would be to shape visitor experiences. Museum exhibits will send out messages that elicit visitor’s feelings and memories with every artefact on display, creating social interaction that stimulates, reinforces or creates new personal reactions.

2.4 Digital Tools for Museums

Over the last years museums and galleries have been experimenting with and introducing digital tools across the visitor experience. Various studies have been carried out to evaluate the effectiveness of exhibition design and visitor behavior and analysis (Falk,2000; Hein, 2002; Othman et al., 2011).

For museums to be able to create more diverse and engaging cultural spaces they need to offer more satisfying museum experiences (Pekarik, 2011). Digital tools have a lot to contribute towards such experiences but need to be developed and implemented carefully so that they enhance rather than detract from the museum visitor's experience.

This chapter looks at some of the main digital tools currently being used in museums. The aim of this review is not to go into the technical details of each technology but to try to understand how such technology is being used for better visitor engagement both within and outside of the museum, before, during and after the visit. These tools have been further analysed during my site visits throughout Europe as part of my observational research. Such digital tools are also being introduced in Maltese museums and cultural heritage visitor centres. The visitor centre at Ħaġar Qim and Mnajdra Temples, managed by Heritage Malta, Malta's national museum agency, was one of the very first expressly designed for school children. An audio visual introduction at the centre's auditorium helps visitors understand what they are about to see and experience at this important World Heritage site. This project, financed through the European Regional Development Fund 2004-2006, is an important milestone for Malta since it put the needs of the visitors at the very centre of the experience, not only in terms of interpretation but also facilities provided. The Malta Maritime Museum in Birgu is currently undergoing a multi-million refurbishment project. Through EEA Malta – Norway funds as well as local funds, this

project has a substantial investment in digitization processes. In fact, between 2020 – 2022 around 3,000 artefacts from the museum will be digitized. Digitization will cover both document digitization, such as old maritime navigation plans and shipbuilding plans, 3D scanning of various nautical instruments and miniature ship models, as well as large format scanning of whole vessels. Through this project Heritage Malta will be setting up a digitization lab that will cater for the needs of the whole agency. The lab will help build a nationwide collections management system complete with digitized captures of both tangible and intangible cultural heritage assets. The digitization lab will also assist in exhibition design especially through the effective use of digitized multimedia content designed for visitors. The digitization unit within Heritage Malta will lead a multidisciplinary team design approach to exhibition design.

2.4.1 Virtual and Augmented Reality in Museums. One of the most significant revolutions in ICT in the last years has been the use of digital tools to create modified realities, be it full virtual reality, augmented, or mixed augmented reality.

Virtual Reality allows humans to visualise, manipulate and interact with computers and extremely complex data (Aukstakalnis et al., 1992). Visualisation comes from the computergenerated display, auditory or other sensorial output to the user who is in a ‘world’ within and generated by a computer. The user can interact with this virtual world in real time. VR applications have spread to every industry and sector. Most VR worlds recreate environments very similar to our own such as in architecture. Some applications, such as scientific simulators or medical VR, are meant to create viewpoints not normally possible in the real world. Other applications recreate worlds which we are not familiar with, such as navigating a huge meta database.

There are different types of VR systems, these include: Window on World Systems (WoW) which uses the desktop monitor as a window into a virtual world, Video Mapping which merges video of the user with a computer 2D model, Immersive Systems which use a teetered or completely wireless head mounted display (HMD) with a variation of this being the VR “Cave” which uses large projection to create an immersive room.



Figure 2.4.1.1 Photos 1 and 2 - Trying out the brand new fully immersive VR Cave at the University of Malta.

Source: Photos were taken by myself at the University of Malta.

Telepresence – the use of remote sensors linked to the senses of a real human operator - is widely used in medicine as well as in deep sea or space exploration. Mixed Reality merges Telepresence and Virtual Reality to create seamless simulation systems, for example a fighter jet pilot sees maps and other important information directly on the screen of his helmet whilst he is flying the jet into action (Nesamalar & Ganesan, 2012).

Over the last years VR hardware has made significant advances resulting in improved quality and lower capital costs. Virtual reality requires significant computer processing power to generate images. Image generation cards are at the core of the image processing, the more

powerful cards can still be very expensive and the image processing PCs still cost thousands of Euros. Various VR manipulation and tracking devices used to interact with objects in the real world exist. These range from simple 2D devices such as mice or joysticks to more complex 6D systems, which work by measuring 6 different readings, 3 for position (X, Y, Z) and 3 readings for orientation (roll, pitch, yaw). Instrumented gloves fitted with sensors and orientation trackers are becoming very popular VR interaction devices. Body suits have extended the concept of the instrumented glove to cover various parts of the body by integrating position and bend sensors to capture motion. The biggest challenge for all these devices is latency which is the time between taking the measurements and relaying it back to the central processing unit of the VR system. Headsets are the devices most associated with VR. The development of headsets has made VR easily and widely accessible even in households. These head mounted displays normally use some form of video display in front of each eye creating a stereoscopic image. Special lenses are used to stretch the field of vision. Modern VR headsets are full of sensors to help with the VR interpretation; these include gyroscopes, magnetometers, accelerometers and structured light systems (Arth et al., 2015).

Head-mounted goggles / displays give a deep sense of immersion. In fact when I was carrying out research at the Guarini chapel hosting the Holy Shroud in Turin as well as in the Domus Aurea in Rome (see Section 3 - Methodology) I noted visitors wearing the headsets displaying exaggerated reactions, indicating that they were completely immersed in the VR experience, almost forgetting the real world.

There are five main methods of virtual reality. Simulators recreate real live scenarios by performing and simulating real live actions. Such systems are used extensively in driving,

aviation, vehicle safety development and safety improvement. Desktop-based VR uses normal computer monitors, without requiring any additional equipment to display 3D vision created by the virtual world. This is extensively used in gaming. The biggest downside to this system is that it has no peripheral vision, thus making the VR experience much less immersive. Avatar based VR allows participants to join the virtual world in the form of a computer simulated avatar or video image. This is especially used in multiplayer / participant environments. Projector based VR is often used where the accurate recreation of an environment is required. Increased realism makes the VR experience more authentic. Immersive systems, VR systems normally created by head mounted sets, create a truly immersive experience; a wide range of sensors and fast real time computing make the user feel that he/she is inside the virtual world. Full body suits, like the Teslasuit (Teslasuit | n.d.), are designed to give the user a truly full body immersive experience.

Virtual Reality systems still face a number of disadvantages. Biggest amongst them is price. A complete immersive VR experience is quite expensive making it unaffordable for most small museums. Technology used for VR experiences is still developing and relatively new. Although VR is becoming much more commonplace than ever before, programmers are still facing a learning curve on how to interact with virtual environments. One of the harshest criticisms of VR environments is the feeling of escapism where people are seen to be escaping from reality into a virtual world.

Training is probably the biggest advantage of using VR. When I was at SITI in Turin (Section 3 Methodology), I experienced first-hand firefighting training using VR. The multiteam training session took minutes to set up whereas a real training session would have involved hours if not days of preparation as well as significant costs. VR training allows trainees to train in real

life situations in a completely safe environment for both the trainee and other actors. VR training has been extensively used in medicine, law enforcement, aviation and the military.

Augmented Reality (AR) differs from virtual reality in that it supplements rather than recreates the real world using virtual objects that appear to exist side by side with the real world. Augmented reality “combines real and virtual objects in a real environment; runs interactively, and in real time; and registers (aligns) real and virtual objects with each other” (Azuma et al., 2001, p.34). AR is not restricted to sight; in fact, it can apply to practically all the senses.

Milgram defines AR as one part of the general area of mixed reality between the real environment and VR (Milgram & Kishino, 1994).

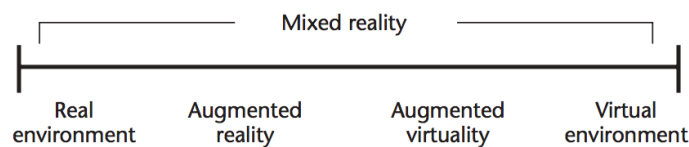


Figure 2.4.1.2- Diagram showing Milgram’s real-to-virtual continuum (Milgram & Kishino, 1994)

There are three main categories of displays to view the merged real and virtual environments - head-worn, projective and handheld (Azuma et al., 2001). Head-worn devices (HWDs) are worn on the user’s head and provide a visual in front of the eyes. Optical see-through HWDs use an AR layer on top of a transparent display, whereas video see-through uses head-worn video cameras to capture video to be used as for the AR layer. Handheld displays use portable handheld, devices with LCD displays that use an inbuilt camera to supply video see-through-based reality augmentation. This handheld display has been used in a number of museums and is

used to provide an augmented view of the real objects with an AR layer. In Projection displays a layer of virtual information is directly projected onto the physical object for augmentation. In a CAVE virtual environment, a number of projectors would project overlapping displays on a very large surface area. Special calibration techniques can be used to project on irregular surfaces (Raskar, Welch, & Chen, 1999). Another form of head worn display is virtual retina display which involves projecting an image directly onto the retina (Pryor et al., 1998).

The book *Understanding augmented reality. Concepts and applications* (Craig, 2013) gives a very good overview of Augmented Reality's development history and how users utilise this technology to interact with the augmented world AR hardware and software. Software for AR content creation is also examined and reviewed. The book examines the advantages and disadvantages of applied augmented reality, whilst the final chapter looks into the future trends of AR, some of which have already become a reality.

Over the last decade VR and AR tools have been introduced to museums to aid with museum interpretation to visitors (Sparacino, 2002), (Vlahakis et al., 2003). These tools try to fill the gaps or disadvantages of other interpretation tools such as text, audio and interactive kiosks. Mobile and handheld multimedia AR devices started being used by Museums to experiment with mixed augmented reality mostly as museum guides offering interpretative or background information on physical objects with AR are no longer being used to simply entertain audiences but as a digital tool to provide meaningful information that improves the visitor's experience. Studies demonstrate that Augmented Reality is able to engage visitors and help them achieve specific learning outcomes as a result of their museum visit (Damala, 2009). Incorporating AR into museums is quite challenging for two primary reasons. Firstly, it is not always easy to blend in an AR experience into existing established exhibitions often relying on other media to portray

the message. Secondly, there is the challenge of tracking original artefacts where marking is not possible. Visitors also need to understand how to engage with and learn from the AR experience, whilst visiting the museum.



Figure 2.4.1.3 - Photo of the ExploreAR unit used at the Cardiff National Museum.

Source: taken by myself during the Museums and Heritage Fair, London 2018, See case study APP2.4.1 in Appendix.

I had the chance to try out the ExploreAR during the 2019 Museum & Heritage fair held in London. It is a light weight, handheld AR unit aimed at creating immersive digital experiences, through the use of virtual and augmented reality, 3D modelling and 360° video and photo. The self-led unit allows visitors to explore museum settings; through a “wow-experience” new ways of interpretation are made available to the visitor.

It is the role of the AR experience designer to select the most suitable devices that museum visitors would use during their visit without burdening or distracting them. Apart from the hardware, the content must be presented in a way that adds value to the exhibited artefacts or collections, whilst keeping the visitor experience at the very centre. Design Thinking methodology, explained in Chapter 6, is an ideal tool to plan and execute an integrated AR experience in the museum visit.

When designing an AR experience, developers must be aware of “Noise” coming from any external sources, such as overcrowded museums, and lack of proper lighting in the case of visual tracking systems or any internal source that disrupts the communication with the receiver. Internal noise could be caused by limitations in tracking technologies such as limitations in sensor or visionbased tracking. Internal noise could be the result of interaction and user interfaces as well as issues caused by the display techniques. Human factors such as fatigue caused by having to hold and point hand held devices make them not very suitable for long museum visits.

The Case study - Museum ExplorAR: National Museum Cardiff found in appendix APP2.4.1 highlights the use of the handheld *ExplorAR* handset within the National Cardiff Museum. This AR handset was used to develop 3 self-led visitor experiences based on augmented reality. This case study clearly demonstrates that when properly used, AR offers huge potential for visitor engagement with more than 99.3% of the reviewed visitors saying they wanted to see more such experiences in museums.

2.4.2 Audio Guides as Digital Tools in Museums. Hand held devices were the first type of visitor technology to be introduced in museums. Developers were intrigued by the huge potential that technology could offer to enhance the visitor experience. Over the last decades the technology and hardware behind handheld devices have evolved significantly but their basic implementation requirements and characteristics as tools to enhance the visitor experience have remained the same. This section discusses the historical development of handheld devices, as well as the requirements for creating effective visitor experiences.

Stedelijk Museum in Amsterdam was the first museum in the world to introduce handheld technology to enhance the visitor experience. The museum wanted a device which the visitor could carry around in the museum, and one which respected the quiet and silence traditionally associated with museum visits. The system introduced in 1952, used pre-recorded guided tour broadcasts in four different languages; English, Dutch, German and French. These broadcasts stored on magnetic tape were broadcast via shortwave radio and a closed loop system within the different halls of the museums. The broadcasts were in turn picked up by small receivers worn by the visitors. Visitors could listen to these broadcasts via headphones as they walked around the museum (Wiese, 1960).



Figure 2.4.2.1 - Photos showing the Philips Short-wave receivers implemented by Stedelijk Museum for their “Short-Wave Ambulatory Lectures”. The devices were developed from an existing system meant to boost hearing for people with hearing difficulties in cinemas. Source: Loic Tallon <https://bit.ly/2OTNbXa>

At the time of launching the above system, the technological limitations of analogue systems created a number of limitations. The biggest of these was the fact that users had no control over the broadcasts themselves. All the visitors would be hearing the same broadcast at the same time and would end up moving all together simultaneously within the museum. Another disadvantage was that visitors could not pause the broadcast to stop and look longer at a specific object.

In the 1970s these limitations were tackled by the use of the Sony-Walkman device. These taped tours were used during the “Treasures of Tutankhamun” when more than 3 million North Americans could experience a museum block buster exhibition in a completely new way one never experienced before. Articles from San Francisco Chronicle described how the public was enthralled by this block buster exhibition which became the talk of everyone irrespective of age or class. (Hartlaub, n.d.).

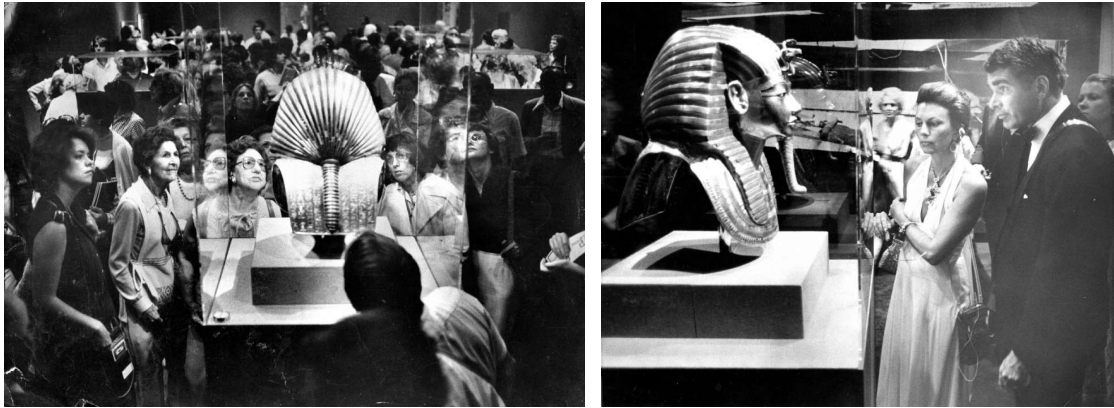


Figure 2.4.2.2- Photos published in the SF Chronicle (09/22/1979, p. 4) and (06/1/1979, p. 25) showing visitors to the “Treasure of Tutankhamun” exhibition. One can see the Sony Walkman devices worn by the visitors.

Source: sfgate.com

The Sony Walkman device allowed visitors to pause, fast forward and rewind narrations on the tape recordings, giving them more control over both speed and route while visiting the museum. Visitors could now spend more time near objects they found more interesting and listen again to narrations they had not understood or which they had found interesting.

Tape based handheld devices had a limitation, however, with the way users could access information. Fast forwarding and rewinding the whole tape to try to find the part which interested you was not very efficient. This all changed with the introduction of Acustiguide’s direct access device introduced at the Louvre in 1993 to cover the museum’s permanent collection. The system known as “Random Access” allowed visitors to switch to any narration within the guide by the click of a button. This made browsing and using the audio guide much more effective and efficient. Since then this technology has been introduced in practically every main museum around the world.

Over the last decade advances in technology have meant that the audio guide’s capabilities have evolved significantly. Today Audioguides have evolved from the portable Audio player technology and the term is now a generic collective name to encompass a variety of

technologies including PDAs, Screen based android devices, video enabled guides, geolocation triggered Guiding Devices and Smart Phones. Technology is expected to go on evolving fast in the coming years, yet it will not be the hardware advances that will ensure effective use of handheld devices in museums. It is the thorough understanding of the visitor's needs and expectations and the discovery of how technology could be used to meet them that will ensure effective visitor experiences.

As explained in the introductory chapter this contemporary approach in museology is all about putting the visitor in the very centre of the museum experience. The Neo-Humanist museum is built around the humanisation of the visitor experience and thus understanding visitor's needs and expectations has become more important than ever (Debono, 2019). It is a sad reality that some museums focus more on technology and hardware specifications and tend to forget what that technology is supposed to do for those who are using it, thus reducing it to an inefficiently used tool.

Most of today's museum visitors are digital migrants or digital natives. These visitors are very comfortable using technology since they constantly make use of it throughout their daily lives. Today's museum visitors are no longer static audiences but more active participants. This trend can be seen in the way people use technology. TV viewers no longer just wait for their TV programme to play on the pre-established TV broadcast schedule. Today's technology allows them to see their favourite shows when they want and where they want. Real time reality shows allow viewers to interact with what's happening on screen. Apart from having access to this huge amount of rich information, today's technology users expect to use this technology whenever and wherever they are. Thus, to remain attractive and relevant to potential visitors,

museums must keep up to date with these visitor needs and expectations when designing visitor experiences.

As can be seen from the examples mentioned above, museums have over the last decades resorted to using technology to meet their visitors' expectations. Modern digital technology allows museums to manage and deliver large amounts of information to the individual visitor in a way to fit their specific learning requirements. The potential of digital technology keeps on growing with the spread of wireless internet, ensuring more effective and powerful visitor experiences.

Handheld devices have 3 unique characteristics that allow these digital tools to deliver personalised museum experiences that other mediums cannot offer.

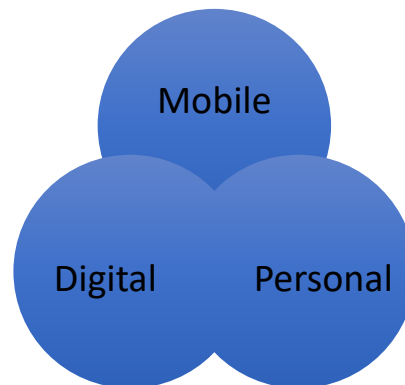


Figure 4.2.3 - The 3 main qualities of handheld technology.

Handheld devices are location independent and can be carried around by the visitor wherever they go in the museum. This allows the visitor to access the information on the guide at anytime and anywhere the visitor wants. With advances in mobile technology and wireless internet the range of mobility has been extended even further. Handheld mobile devices are digital. Advances in technology, particularly in the area of Nano supercomputing, means that very small devices can offer very powerful processing power, which could in turn be harnessed

by designers to offer even more engaging visitor experiences. Handheld devices encompass these 3 qualities making them different from interactive touchscreen kiosks, museum catalogues or docents as means of communicating information to visitors.

It is interesting to note that, although audio guides are the principal digital tool employed by museums to enhance the visitor experience, the amount of available research on their use in the museum context is scarce or not available. Since the very beginning, the market has been dominated and controlled by a few large suppliers. Very often the model employed by such companies was to offer the museum a leasing arrangement where the supplier would offer a complete product (including hardware, charging stations, multilingual content and sometimes even staff to hand out and collect the guides) in return for a small share of the ticket sales. Museums have always found such an arrangement attractive since it meant that with minimal effort and no capital investment, they could avail themselves of a digital tool which could significantly upgrade the visitor experience. Tight commercial rivalry between the main two players in the market, Acoustiguide (www.acoustiguide.com) and Antenna (www.antennainternational.com) has meant that market and developmental research was a closely guarded secret by these companies. Over the last decade new companies such as the German company Tonwelt (www.tonwelt.com) have successfully penetrated the market and are seriously challenging the big market players. The modern multidisciplinary approach in museum visitor experience design brings together experts from different spheres that are now looking beyond the suggested implementation of audio guides by the suppliers.

The book *Digital Technologies and The Museum Experience, handheld guides and other media* (Bowen et al., 2008) looks into a number of problems related to Handheld devices. It questions whether extreme personalised experiences created by handheld devices can create

socially isolated visitor experiences. It examines the extent to which audio guides manipulate or interfere with the message the museum is expected to pass on to its visitors. The book also questions whether digital tools are a passing trend or are set to become permanent enhancements in museums and looks at the theoretical and practical background that is needed when implementing these tools in museums.

An interesting case study focusing on the implementation of audio guides in museums is the one reviewed in APP2.4.2 for the Museo Egizio in Turin. This project used Design Thinking Methodology to redesign the audio guides from a visitor-centred point of view.

2.4.3 3D Scanning and Printing for Museums. 3D scanning and 3D printing are increasingly being used in museums and archaeology to help in cultural preservation and information dissemination. This technology provides curators and researchers with the ability to capture in 3D, with much more detail than the standard 2D photographs, ancient artefacts and objects. These detailed digitized captures allow archeologists, museologists and other industry experts to better study, restore and archive cultural heritage.

The latest 3D scanning technology is being used to capture in 3D entire heritage sites. The image below shows the output of a scan of the huge water cisterns built by the Knights of St John in what was probably the quarry site used to extract stones to build St. John's Co-Cathedral and the Grand Master's palace as well as a small part of the underground tunnels beneath the City of Valletta excavated during World War II to act as air raid shelters for the city's population.

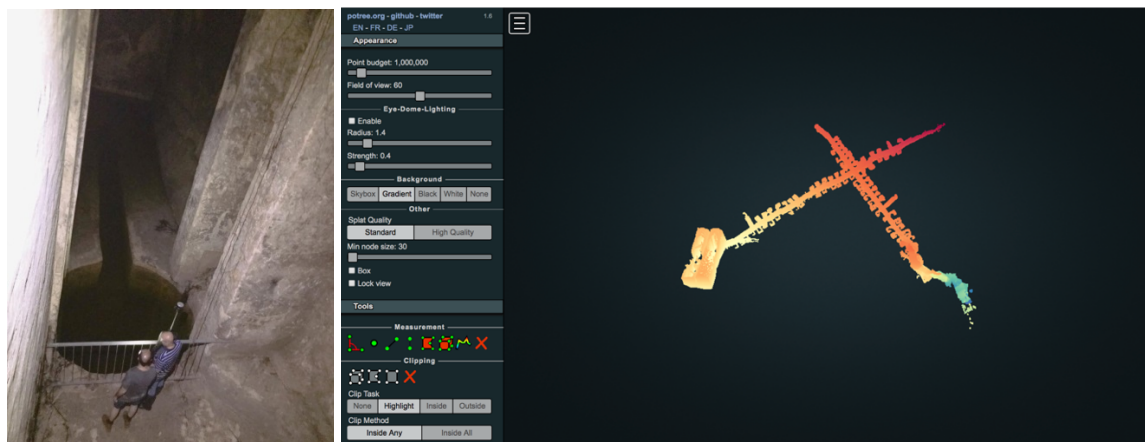


Figure 2.4.7a - Scanning the huge Valletta water cisterns and maze of WWII shelters using a Greenvalley LiBackpack C50 360-degree scanner and check integrating the 360° panoramic camera with LiDAR and SLAM algorithm to produce true-colour point cloud data. Source Photo left : taken by myself Photo Right: Prof Saviour Formosa University of Malta, Department of Criminology.



Figure 2.4.7b Photos taken whilst experimenting with laser scanning on the outside and inside of the White Tower in Mdina with Prof Saviour Formosa
Source: taken by myself.

3D scanning offers various advantages to museums. It offers very high levels of accuracy of details which are often not even visible to the naked eye. Many museums are using 3D scanning to create their own 3D repository archives of artefacts instead of relying on traditional 2D pictures. 3D mapping, similar to the example given above, can be used for the preservation of cultural heritage. Should something happen to the historical site, such as through conflict, natural disasters or simply as a result of deterioration brought about by the passing of time, the 3D mapping would provide very accurate data of the historical site prior to the disaster (Barsanti et al., 2012). Museums are using 3D scanning to extend their collections beyond the physical building of the museum itself. Visitors can now visit museum exhibitions from their computer in the comfort of their home (Corcoran et al., 2002). 3D scanning is also being used to make accessible via virtual museums and online collections previously hidden artefacts from museums' reserve collections. 3D scanning plays a very important role in the restoration and replication of artefacts (Rocchini et al., 2001). Before replicating an artefact, a 3D scan is made, and the digital file is then used to 3D print the copy of the piece.

3D printing technology has seen huge improvements in the last few years; it is continuing to evolve and has great potential for all sorts of industries and sectors. As prices of 3D printers have gone down drastically, 3D printing has become more accessible than ever. This section looks at how 3D printing technology is being adopted by museums and how it can enhance the visitor experience.

3D printing allows the making of a three-dimensional physical object out of a digital model which can either be tested by software or out of existing scans and reproductions of physical objects. This technology has a huge range of possible uses within museums and may be the ideal tool to make collections and museums in general more accessible.

The average time spent in front of a museum artefact is between 15 to 32 seconds (Smith & Smith, 2001). This time frame is too short to allow the visitor to really appreciate and learn anything from the exhibit. 3D printing may be used to increase visitor engagement by taking works which previously visitors could see but not touch and placing them right in their hands. Traditionally, museums have been no touch zones where touching artefacts was strictly prohibited. Viewers would walk along galleries and museum halls, read captions, listen to audio guides and look at artefacts behind the security glass of display cases. 3D printing allows the accurate reproduction of priceless, delicate artefacts which cannot be touched by visitors, and allow the latter to touch and play around with these 3D printed replicas. 3D printing and scanning can improve the connection between visitor and museum artefact and increase the time spent interacting with objects. It provides kinetic, sensory and object-based museum learning. This learning experience can be extended further by involving participants in scanning and 3D printing their own museum objects.

To illustrate how 3D printing is being used in museums around the world I looked into 3 different case studies. These can be found in the Appendix at APP2.4.3. The New York Metropolitan Museum of Art has made 3D models of artefacts and instructions on how to print them using a 3D printer, allowing artefacts to be taken out of the museum with the originals never leaving site (App2.4.3a). The Victoria and Albert GOSH project allows children within the Great Ormond Street Hospital to manipulate 3D artefacts from the Victoria and Albert Museum and create their own 3D printed artefacts (APP2.4.3b). The last case study shows how the Prado museum used 3D printing to increase accessibility to visually impaired visitors (APP2.4.3c).

As 3D printing technology becomes more accessible, we will see it being used more in museums to constantly improve access and interpretation. This technology fits very well into the visitor centred approach as it brings the visitor closer than ever to the museum artefacts. It can also play a very important role in cultural conservation and research.

2.4.4 Museum Projection. In the mid-19th century, large size panoramic paintings became very popular with audiences as their large size provided a quasiimmersive experience. With regard to digital tools for museums, curators often go to more technologically complex solutions such as touchscreens and VR or video enabled audio guides. Large format projectors have become very powerful, offer clear projection and offer great value for money, making them very valid digital interpretation tools for museums. Projectors combined sensors with interactive software can be used to create effective interactive projectionbased installations.

There are currently four main types of imaging technologies used in projectors found in museums; DLP (Digital Light processing), LCD (Liquid Crystal Display), LCOS (Liquid Crystal Technology on Silicon) and Laser Raster.

Technological advances have made the older generation of Cathode ray tube projectors obsolete. DLP projectors come in two varieties, one-chip or three-chip. Millions of micro mirrors are housed on each chip and are used to reflect light at thousands of times per second. Whereas one-chip models can produce more than 16 million colours, the three-chip projectors can produce more than 35 trillion colours. DLP projectors produce the more lifelike and natural projections. Images are more fluid and crispier compared to LCD technology. LCD based projectors use polarized mirrors that allow only certain colours of the light spectrum to pass. Light is separated into 3 separate channels of red, green and blue which are then re-assembled through a prism. LCOS is a hybrid technology between LCD and DLP. As we move into 2020 many DLP or LCOS projectors are starting to use lasers as a light source.

Les Carrières de Lumières is an immersive projection experience setup in the disused quarries in Baux-de-Provence. Using multiple projectors, the sides, roof and floor of the quarries are turned into huge art canvases of famous masters such as Monet, Renoir, Gaugin, Klimt,

Michelangelo, Chagall and Picasso. Animation and sound create a truly immersive experience for visitors. More information can be found in the Appendix APP2.4.4a.

The usual keyboard, mouse and screen setups for user interactivity are normally avoided since they feel out of place in the tactile museum experience. Another reason for museums and galleries to offer interactivity, while at the same time keeping technology in the background, is that not all users are computer literate. An interesting use of keyboard free interactivity is the exhibition by the Fondation Beyeler of the works and life of Paul Gauguin (APP2.4.4b).

Interactive table tops have been used in museum displays for two specific reasons; the look and feel of the familiar horizontal workspace and the use of hand gestures or common everyday looking objects as tools to interact with the displayed information. A survey carried out on the motivation for using table top displays found that table top displays encourage a collaborative, more familiar, informal and inviting atmosphere. Some of these exhibits use to their advantage the experience of working with other visitors around the same table (Hancock, 2015) Interactive table tops use the standard projector and sensors to be able to track hand or special object movements and use them as inputs to interact with the image being projected. Interactive projection uses one of two available technologies, one is DLP and the other Infrared, with the first being the more common. Interactive projectors using DLP technology overlay a special pattern, which cannot be seen by the human eye, onto the projected image. When this pattern is interacted with, it sends data back to the projector which in turn shows movement onto the projected surface (Geller, 2006). Infrared projection uses a second camera separate from the image projection lens to track movement. Upon contact with the projection surface, Infrared light is then transmitted back to the camera and movement recorded very similar to how a wireless

mouse would work (Lee et al., 2005). Interactive projection display is not limited to one single projector; by daisy chaining projectors, huge and very long projections can be created.

Large scale interactive floor and wall projection can turn museum spaces into complete immersive spaces. These kinds of digital exhibits use the latest creative digital tools to create visitor centred exhibits making them attractive and relevant to tech-savvy visitors. They combine high resolution projection, motion detection sensors and interactive software to create immersive experiences (Brown et al., 2013). Visitors use their body including hand and leg gestures to interact with the projection. An example of large scale interactive projection can be found in Appendix APP2.4.4c which highlights the world's largest immersive experience at the Wu Kingdom Helv Relics Museum.

Holograms A German circus, Circus Roncalli, has used holograms to replace shows by live animals. The futuristic holograms are the answer to the fight against animal cruelty often associated with circuses. These 360° 3D holographic animated images, created using eleven optima laser ZU 850 projectors, fill the whole 32 metre wide, 5 metre deep circus arena. Audiences have responded very positively to the giant holographic elephants, horses and even fish that move magically around the stage.

2.4.5 Digital Tools for Cultural Heritage, an EU Perspective. Over the last decades museums have been very active in the areas of digitizing collections. Computer databases containing data about collections have replaced manual card driven collections management systems.

Europeana brings together thousands of European museums, archives and libraries to make accessible, and share cultural heritage with the general public. Over 50 million digitized items including artworks, music, books and more, make up the thematic collections split into art, music, photography, fashion and World War I (Europeana, n.d.). Europeana has contributed significantly to bring together and present Europe's rich and very diverse cultural heritage and make it accessible via the internet. It has promoted digitization of cultural heritage across the European member states and contributed to the growth of such sectors as tourism, media and education (Pagel, 2008).

The European Union has funded many projects targeting digitization of cultural heritage and museum collections, through the FP6, FP7, H2020, Creative Europe and COST programmes. The following are just a few of the most important ones.

The 3D-ICONS Project (Guidi, Barsanti, Micoli, & Russo, 2015) was designed specifically to add accurate 3D models of architectural and archaeological heritage buildings of outstanding cultural importance to the Europeana database. Through this project alone, around 3,000 3D models were added. These models can also be accessible via the web from basic personal computers. They can also be accessed via the portal <http://3dicons.ceti.gr/> as well as through Europeana.

Inception (www.inception-project.eu/) targets 3D modelling of cultural heritage through time-dynamic 3D reconstruction not only of physical artefacts but also of built and social environments. The project takes a multidisciplinary approach with a wide representation of skills

and organizations. One of the case studies covered by Inception was the Panagia Asinou Church in Cyprus, introduced to me by Prof Ionides Marinos from the University of Technology in Cyprus during my Short-Term Scientific Mission in 2019.

‘GRAVITATE’ (gravitate-project.eu/) is an interesting EU funded project which aims to help scientists to Re-Assemble fragments of broken heritage artefacts, Re-Unify Parts scattered along collections and Re-Associate artefacts with common features to help better understand past societies.

Another H2020 project targeting cultural heritage digitization is scModules (www.secondcanvas.net/) which aims to digitize museum collections in super-high resolutions (SHR). Through this project museums can avail themselves of a full day of digitization with all costs covered by the programme.

Time Machine (www.timemachine.eu/) is an H2020 project which aims at using the latest digital breakthroughs to connect the rich history of Europe’s past, allowing the public to travel through space and time. The project brings together academics and researchers, heritage organizations and industry from across Europe in order to create a truly ambitious project aimed at revolutionizing the way the public experiences Europe’s history and culture, spanning thousands of years.

The cooperation between European countries on the digitization of cultural heritage was further strengthened on the 9th April 2019 following the signing of a ‘Declaration of cooperation on advancing digitization of cultural heritage’. The three pillars of the declaration include: a Europe wide initiative for 3D digitization of European heritage sites, artefacts and monuments, the use of digitized cultural assets to encourage citizen engagement, and a European wide cooperation and capacity building in digitizing cultural heritage.

Europe has a very rich cultural heritage spanning thousands of years. It is the cradle of Western civilization and through its various funding programmes, including huge platforms such as H2020, is investing billions of Euros in innovative projects targeting cultural heritage preservation, interpretation and dissemination. These funded projects bring together the best scientists, researchers, academics, practitioners and industry to develop projects in line with European Cultural Heritage goals and ambitions as described in the EU Cultural agenda. Between 2014 and 2020 the EU invested around EUR 4.7 billion in heritage (European Structural & Investment Funds, 2019). The projects research, investigate, experiment and set the standards for the use of digital tools in museums from the widest possible perspective, but all aimed at making cultural heritage more accessible by everyone.

2.4.6 Gamification. Gamification is a process of introducing game mechanics into existing processes and situations in order to encourage user participation and engagement. Gamification has been applied in every imaginable scenario from industry to healthcare to finance, education and science. By introducing elements of game design into non game scenarios, the latter become more fun and engaging.

In her book, *Reality is Broken* (McGonigal, 2011) game guru and developer Jane McGonigal (2011), explains how games can make a positive influence in people's lives. All games share four basic features: a final goal, rules, timely feedback and participation out of free will. Within these traits, gamers experience "positive stress" and, after hard work and achieving the ultimate goal, experience a strong sense of pride. This enjoyable stress when immersed in gameplay is possible when the game offers clear goals, appropriate as well as customizable difficulty levels and instant feedback. The bigger the effort that gamers are ready to put into a game, the bigger would be the reward and thus the better the game. When a game is too easy it immediately becomes boring. If on the other hand a game cannot be learned and mastered it will not be played by enough people and will force the company making it into bankruptcy (Gee, 2003).

In the western world, digital games are widespread and children from a very young age are exposed to, and often hooked on, digital games. Field studies conducted by the University of Wisconsin showed that young seven year old children playing "Age of Mythology" had not only mastered the gameplay itself but, as a result of the game, had read about mythology both within and outside of the game, by researching websites and borrowing library books about mythology as well as drawing and writing about mythological themes (Gee, 2003). This is informal education at its best.

The spread of digital game-boxes, the internet, tablets and smart phones has significantly contributed to the wide spread of digital games. People from all over the world spend billions of hours each week playing games and the gaming industry has become one of the leading industries worldwide.

As explained in chapter 3, towards the end of the 20th century, museums started to move away from the traditional ways of transmitting knowledge to visitors to more constructivist interpretative methods. Today more museums are exploring ways of adopting gamification in their narrative. Creating effective gamification within museum contexts is much more than creating games and the hardware needed for them. This paradigm shift is discussed in the book, *From Knowledge to Narrative* by Lisa Roberts (2014). Whereas in the old paradigm knowledge is a product, by contrast game-based learning is firmly established in constructivism. As Hein (2002) explains, learning “is not a simple addition of items into some sort of mental data bank but a transformation of schemas in which the learner plays an active role and which involves making sense out of a range of phenomena” (Hein, 2002). Each visitor’s learning experience thus becomes a very personal understanding or explanation of any given event (Dierking et al., 2000a).

As discussed in Chapter 3, of the literature review, about museum learning, the latter provides ideal informal learning environments (Pierroux et al., 2007). In recent decades, multimedia games have been used to introduce gamification in museums to successfully support museums’ efforts in creating more effective visitor experiences. A wide variety of digital tools such as AR and VR, 3D reconstructions, proximity sensors, simulators, multi-touch screens and interactive projections have been used to create situations where the visitor becomes more of an actor and less of a visitor. The museum visitor becomes an integral part of the story being told by

the museum. Whether it's a scenario in *Age of Empires*, a new city within *SimCity* or a skate park in *Tony Hawk*, players can use the software that comes within the game to create their own customized scenarios. This is a huge difference from formal educational settings where very often students do not produce knowledge and have to follow preset and very inflexible curricula (Brown, A. L., 1994).

Within classrooms and other formal learning settings, knowledge transfer often involves asking questions or solving problems in structured ways. In a museum setting where learning is of an informal nature, the visitor learns independently. Problem solving may be introduced to encourage the visitor to learn about the topic by building on existing knowledge. Appropriation is a process whereby visitors make a problem their own, by making it relevant through personalization (Connolly, 2011). The appropriation of a problem is called devolution (Brousseau & Balacheff, 1998). In gaming players have clearly defined goals to achieve (e.g. build a ship that can travel fast – “Full Steam Ahead”) and this as well as instant feedback can help the player assess if the goal was achieved and, if not, what needs to be amended. These two factors make problem devolution easier; as a result, players are free to perform the required tasks according to their own understanding of the situation rather than someone else's expectations, and secondly, the instant feedback will help the players reassess their actions and behaviour in order to rethink their decisions to improve performance.

In effective games, players are helped to build skills that are needed to solve more complex problems in later levels. Thus, initial game levels can often be considered as hidden tutorials.

In fact, cognitive science has shown that when presented with problems and issues in a fruitful way and order, people can use these to build good generalizations for later problems. Good

games can order problems in a helpful way whilst at the same time creating a cycle of player expertise. The most important factor that drives learning is motivation, and since good games are very motivating to players, we can safely assume that games have the potential to drive learning.

The spread of the internet has made possible a new form of game play. Large multiplayer games see hundreds, sometimes thousands, of players, from all over the world play games as teams. These teams often use different but overlapping player skills and shared knowledge to achieve the final game goal.

Two examples of gamification within physical museums settings, demonstrating how museums are using games to inspire visitor learning and participation, can be found in the Appendix. APP2.4.6 which shows how gamification was used to explain the carbon cycle within the Atmosphere gallery of the Science Museum in the first case study, whilst the second case study showed how games helped young visitors understand the concepts of paddle power and ship design through the 'Full Steam Ahead' game at the SS Great Britain.

Another challenge that gamification can help museums with is dwindling museum visitors. Gamification can help with audience diversification by attracting new types of audiences such as younger visitors. Some museums tried to do this by developing virtual museums where their physical exhibits are displayed digitally, yet the challenge of retaining repeat visitors and artefact knowledge transfer to the visitor is no easy task. Gamification may offer a solution to both issues. The article *Use Cases for Gamification in Virtual Museums* (Döpker, Brockmann, & Stieglitz, 2013) - presents five different use cases using gamification to develop a virtual museum guide.

Visiting a virtual museum is easy and practically effortless. All that the user needs is a computer or mobile device and an internet connection. Virtual museums offer many innovative

possibilities to present content in an innovative and engaging way to a significantly larger audience. By introducing gamification in virtual museums, visitors will have the hardware resources and time to experiment and play these games and, if appropriately designed and presented, can maximize the benefits for informal learning and repeat visits.

2.4.7 Digital Signage and Touch Screen Technology. Digital displays offer many advantages over traditional labels and text based didactic boards. Such displays allow for content to be easily changed and can include much more visually appealing material such as animations, videos and photographs. Using touch screens, the user will also be able to select the specific content he/she wants to see and the desired language where multilingual content is available (Thomas & Mintz, 1998). Displays have become highly affordable and often come with an inbuilt media player to allow continuous content looping of a playlist. Some of the more complex display systems come with dedicated content management systems which allow for remote and scheduled updating of digital content on these screens. Digital signage within museums is also very popularly used for internal signage and marketing. The ‘September 11, National Memorial & Museum’, in Manhattan, uses digital signage to communicate to visitors, through more than 30 screens including professional monitors, video walls and interactive touchscreens spread throughout the museum. Digital signage is used to effectively target the more than 20,000 visitors per day that visit the museum. Content for these screens is produced inhouse and remotely updated onto the specific individual screens (Brightsign, n.d.).



Figure no 2.4.7.1 - Information Screen, 9/11 National Memorial & Museum Manhattan. Source: Brightsign, <https://www.brightsign.biz/customers/museums/911-memorial-museum>
The above photo shows a remotely updated information screen with information about the upcoming tour schedule including live updating of availability for the different tours.



Figure no 2.4.7.2 - Information Screen and Signage, 9/11 National Memorial & Museum Manhattan.
Source: Brightsign, <https://www.brightsign.biz/customers/museums/911-memorial-museum>.
Directional signage with embedded digital screens showing upcoming events within the Auditorium.

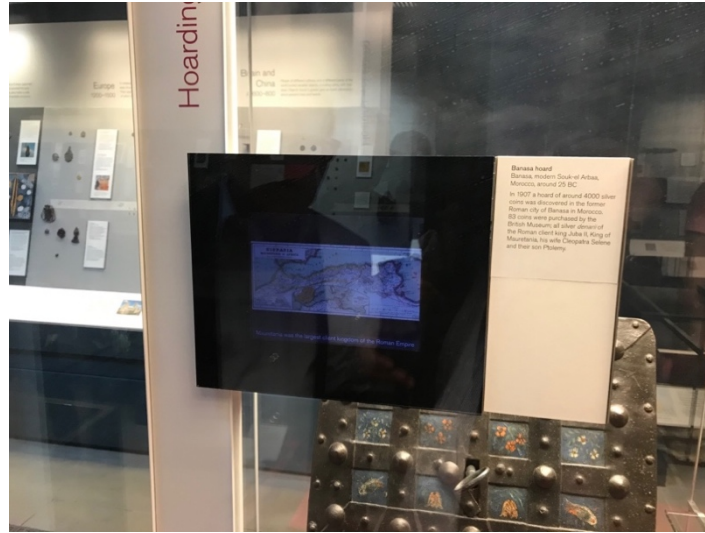


Photo showing Hoarding display at the British Museum London, 2018.

Source: Taken by myself.

One of the displays at the British Museum Money Gallery, showing a small digital signage screen embedded into the showcase glass, showing animated information about a hoard of 4000 Roman coins discovered in Banasa, Morocco.

Digital signage can also be used by museums to create new hybrid exhibits made up of the existing museum artefacts merged with new digital technology. One such example was “Living Rooms” a video installation at the Louvre museum by Robert Wilson. Several famous paintings such as the ‘Death of Marat’, ‘Mademoiselle Caroline Riviere’ and ‘The head of Saint John the Baptist on a charger’ were recreated by incorporating a digital representation of Lady Gaga. The artist managed to create a powerful juxtaposition of classic artworks and modern digital tools to create a provocative result that challenges the boundary lines between pop culture and traditional art.

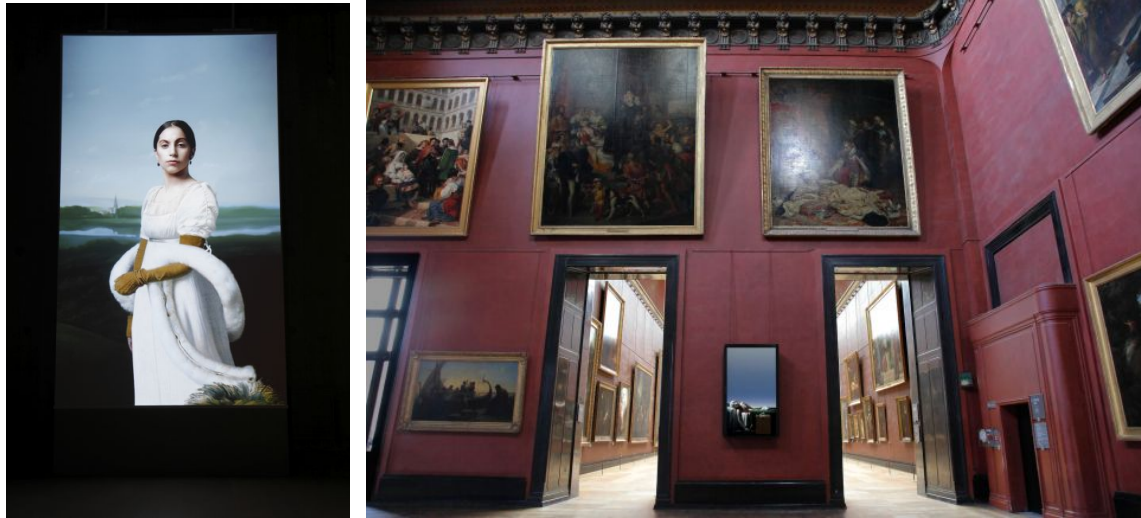


Figure no 2.4.7.2 - Living Rooms, Musée du Louvre, Paris.

Source :BrightSign

<https://www.brightsign.biz/customers/museums/louvre-paris>

Touch screen technology is one of the most popular forms of digital tools which museums use to enhance interpretation for their collections. Most museums appreciate the benefits of investing in interactive displays, whether video walls, PDAs or Smartphones, digital embedded exhibit displays, touch tables or info kiosks as a way of increasing the visitor time spent with the museum exhibits. Such technology is meant to encourage social interaction and discussion (Aoki et al., 2002; Fleck et al., 2002).

It is widely accepted that such interactive displays add fun to the visitors' experience. Decreasing implementation costs related to hardware make such interactive displays attractive to install, yet without a proper understanding of how they should be used, these systems may fail to achieve the desired results in improving interpretation.

The Fortifications Museum in Malta is one such example of how interactive technology alone does not improve interpretation. The interpretation centre is housed in a 16th century building along Valletta's fortifications. Following a massive EU funded restoration project, it

was opened to the public in 2013 (University of Malta, 2013). When opened, this was the first museum in Malta to extensively use digital tools to aid with interpretation. More than 22 state of the art touch screen units, half of which were specifically designed to be wheelchair accessible, were to be used throughout the museum to provide information about Malta's fortifications. The biggest problem with these installations, as can be seen from the case study, was that the content, although highly informative and accurate, was not presented in an attractive way. PowerPoint was used on each unit to create a slideshow with back and forward buttons, making the content presentation quite boring. The content programming approach used did not make full use of the hardware's potential, nor did it focus on the visitor's point of view but was rather an academic presentation by the curator to the public. Another lesson that should be learnt is that just a short while after the launch of the museum, most of these touch screen units were not working as there was no maintenance to the hardware.

Like other digital tools touch screen technology is evolving rapidly and becoming much more cost effective. Understanding the different technologies available, helps museums make the right choices of hardware. There are currently 4 principal touch screen technologies available on the market. These are capacitive, infrared, resistive and surface acoustic wave (SAW).

Blackbox-AV, one of the UK's biggest audio visual interpretation solution providers for museums and heritage sites, stated that one of the most common questions that they received from museums is related to the choice of that screen technology which should be implemented in their interpretation projects (Blackbox-av, n.d.).

Capacitive technology uses the touch of a human finger or specialized input device to conduct a small charge to the point of contact turning it into a functional capacitor. The exact location of the point of contact is measured through the change in the electrostatic field. Most

capacitive touch technology is now using multi touch screens allowing more than one contact point on the screen. This kind of technology offers many advantages including, excellent image quality, high sensitivity, multi touch capability and sleek design. Capacitive technology only works when touched with human fingers or other conductive materials.

Resistive technology works by having two glass layers on top of the screen, and, when the upper layer is pressed, the two screens touch and register the input point. The biggest advantage of this kind of technology is that any object can be used to touch the screen. However, although very accurate, they are also more prone to damages and not very sensitive to a light touch.

Infrared technology works by placing a grid of infrared lines with the point of contact location being recorded when the grid pattern is broken. This technology works with any object as an input and offers great image quality. It is ideally suited for outdoor installations. There are also a number of disadvantages associated with infrared technology in touch screens. These include price, the high-bezel frame to hide the infrared sensors and more frequent cleaning to avoid interference from dust which, in bright light, can interfere with efficient operation.

Surface acoustic wave (SAW) uses ultrasonic waves projected onto a front panel. Controllers can pinpoint the exact touch location by identifying changes in these waves when the front panel is touched. This technology is sensitive to gloved hands, no overlays are used and the screen quality is very clear. The disadvantages of this technology include the fact that it cannot detect motionless touch after the initial touch point, it requires regular cleaning and is more expensive when compared to other technology.

The touch screen on its own cannot do anything and needs to be connected to a central processing unit. A wide range of industrial heavy duty and robust PCs are used in kiosks, touch

tables and video walls. Very often these are Windows based machines, making it very easy to programme them, and install 3rd party software on them.

Following an analysis of the pros and cons of each of these technologies Blackbox-AV, (<https://www.blackboxav.co.uk/>) (Blackbox-av n.d.) highly recommends the use of capacitive touch technology as the best form of touch screen technology to be used in indoor museum environments. This technology is nowadays widely implemented into various forms of the screen systems including touch tables, frameless all in one touch systems and touch based info kiosks. This was the chosen touch screen technology used for the Albert Durer info screen highlighted in the final project of my research.

The touch screen goes against one of the oldest rules since museums were created – that of not touching anything. Not only are visitors allowed to touch but they are encouraged to do so!

2.4.8 Websites, Social Media, User-Generated Content and Mobile Apps. This chapter brings together 4 digital tools of the online connected world, websites, social media, user generated content and mobile apps. A thorough examination of these topics reveals that every single one of them, given the depth of the subject matter, merits a Masters research on its own. It is also clear that, to be able to successfully use these tools, a multidisciplinary approach of experts working together is needed.

2.4.8.1 Websites. Over the last years the internet has revolutionized the way organizations speak to their customers, and museums are no exception. Web 2.0 has given access to Museums a plethora of tools for sharing information with the public as well as increasing interaction with existing and potential visitors (Kent & Taylor, 1998). The UNESCO (2003) Charter on the

preservation of Digital heritage recognized museum websites as an important tool for communicating and preserving cultural heritage as early as 2003. [Click or tap here to enter text.](#)

The primary aim of the museum's website is to kindle interest in the museum's potential visitors and lure them to visit. By attracting them to virtually visit the museum's collections and prized artefacts, the museum hopes to inspire them to, subsequently, physically visit the museum. Physical museums should likewise inspire satisfied visitors to visit the museum's website to bridge the visit and post-visit learning. In both instances this feedback loop should result in increased visitors to the museum. Designing effective museum websites that manage to attract and retain visitors, pre and post their visit, is not an easy task. Museums should continually be asking themselves questions such as: Why would people want to visit the museum website? How would the website influence the potential visitors' decision to visit the physical museum? What do visitors to the website expect before and after the visit? Only by asking and carefully analyzing such questions would museums be able to deliver effective websites. Websites can make visitors feel connected, irrespective of whether they are physically in or out of the museum.

New forms of interactivity, information presentation and manipulation create new online learning experiences (Hamma, 2004) . Websites offer a unique way of presenting information that would not be possible in a physical tour or a book. One such example is the analysis of museum paintings; online visitors can explore the different layers of a painting by means of infrared scans, x-ray images, pigment information and much more.

Website personalization allows visitors to personalize the museum's website for their needs. Some museum sites like the San Francisco Fine Arts Museum and the Metropolitan Museum of Art are experimenting with website personalization by allowing visitors to curate

their own collections of favourite works of art by adding or removing artefacts from their own personalized catalogue (Douma & Henschman, 2000). As the Humanist or Visitor Centred Museum philosophy gathers momentum, so will the increase for more personalized museum web content increase (Bowen et al., 2004). Responsive web-design allows websites to reshape themselves according to the device they are being viewed on. This is especially important in the case of mobile devices, and, since the majority of users use mobile devices to browse the internet, having a responsive mobile friendly museum website is now a must.

One of the most common concerns faced by museum professionals is the dilemma of making the physical collections available online and the risk that this might lead to fewer visitors visiting the physical museum. Surveys have shown that online museums websites actually drive traffic to the physical museum rather than eating away from the current attendance. Planning a museum visit is the primary reason for visiting the museum website (Goldman, Schaller, & Adventures, 2004b). It is very interesting to note that 57% of people surveyed said that online information increased their desire to visit the physical museum, whilst 70% of museum visitors would have actually looked for online information prior to their visit (Chadwick, 1998).

Many studies have been carried out to identify the characteristics of the online museum visitor (Kravchyna & Hastings, 2002), in order to find out if these are the same as the physical museum visitors or completely different (Herman et al., 2004; (Falk & John H., 2006). Such studies can help museum professionals improve their relationship with visitors. (refer to Chapter 2 of the literature review section 'Understanding Museum Visitors').

A study conducted with more than 1,200 online visitors to nine different museums looked at the role of museum websites in relation to the museum visitor. Results gave an insight into the use of

the museum website both before and after the visit and showed that visitors use museum websites to complement rather than replace the physical visit (Dierking et al., 2000b; Marty, 2007). The study found that visitors expect museums to provide websites that met their needs as websites played a very basic important information resource required to build a relationship between visitor and museum.

Like any other form of websites, museum websites need to rank high in search engine results. Search engine optimization and online marketing ensure that the museum's website is found. Although the exact formula to ensure high search engine ranking is not known exactly, one of the most important factors affecting high rank is content. Fresh, original, engaging, well presented, properly structured and web written content ensures that search engines index and rank the website highly in search engines result pages.

2.4.8.2 Social Media and Museums. Social Media is one of the biggest digital technological innovations revolutionizing the way museums communicate with their audiences. Museums may not always manage to participate in this social media revolution mostly because of lack of knowledge on how to grab audience attention in such a specialized and particular media. Social media participation highlights once again the need for a multidisciplinary approach by content providers and technology specialists who need to work together to effectively harness social media's powers. Initially social media was used by museums to advertise upcoming events or exhibitions but it soon moved into interactive media and user generated content.

Technically museums have a huge amount of information that can be digitized and communicated via social media, but for this to be done effectively, a very good understanding of

the workings of the social media platform being used and the audience profile is required. The five most popular western social media platforms used today include Facebook, Instagram, Twitter, Snapchat and Pinterest. The social media world is constantly evolving, morphing and reinventing itself to survive, grow and meet the changing technology and user needs. Rather than focusing on the specifics of individual social media platforms one can look at business social and online media marketing and apply most of its concepts to marketing museums onto social media.

Social media engagement is an integral part of the museum's marketing and communication team, and must as such be continually informed of the ongoing events, activities, special exhibitions and general happenings in the museum. Having a robust internal communication strategy ensures that information which needs to be communicated to the general public via social media does reach the social media team. In order to successfully engage social media, the museum must have a well-planned social media strategy (Chen, 2018). This normally starts off by identifying the museum audiences, both physical and online. Demographic metrics such as age, gender, location, income and education levels help create a clearer picture of both the existing and potential audience that need to be targeted. Clearly defined goals are needed; these may be educational goals or ones aimed at increasing brand awareness, sales volumes or income. These goals will set the tone of posts and tweets. It is essential to find the right voice that reflects the museum on social media. A well-developed brand voice blends into the overall museum brand guidelines and will help the museum stand out on social media. In the absence of a clear brand voice on social media, the museum will end up annoying, confusing and ultimately driving away hard-earned followers. Another thing to avoid is bait posts or the posting of inaccurate or misleading information.

Monitoring and responding to audience engagement is critical. Social media followers use social media not only to follow what the museum is saying, but also to communicate directly in a way which is perceived as being faster than email. Museums need to plan social media content. Well researched, interesting and fun posts need to be planned and scheduled in advance in order to ensure no gaps in the social media communication. Posts need to be monitored to see what is working and what is not attracting viewer feedback. This is especially important if the museum is managing its own social media advertising campaign. Social Media community guidelines outline what the museum tolerates and what can be grounds for being blocked or reported. The Solomon R. Guggenheim Museum Public Social Media Community Guidelines (2018) include very clear instructions regarding the type of content shared in posts. (Guggenheim, 2018).

2.4.8.3 User Generated Content. User Generated Content (UGC) refers to images, videos, text and audio created by users and uploaded onto social media (Krumm et al., 2008) . UGC includes testimonials and reviews posted on third party sites such as Google business pages, Yelp or TripAdvisor. International media houses and news channels adopted the concept of user generated content in the early 2000s, encouraging viewers to submit their own content (Berthon, et al., 2015). User generated content is not limited to social media platforms such as Facebook and Instagram. Sites like TripAdvisor and Booking.com use UGC to rank restaurants and hotels in a democratization process which involves the feedback of hundreds of thousands of similar visitors and consumers (O'Connor, 2008).

Museums need to adapt their communication strategies to the evolving needs of their audiences. Embracing social media, digital marketing and being present in online spaces is no

longer a choice; otherwise museums risk falling behind and losing contact. Museum audiences are constantly evolving, and so are their needs and expectations. A recent study by researcher Colleen Dilenschneider (2019) shows that 35% of the general population and 40% of millennials feel they were not interested in history and art museums. By interacting with potential audiences on social media, museums can learn and understand the diversity of audiences and their expectations in order to be better geared to meeting them. User Generated Content is important and valuable for museums because a satisfied visitor is the museum's most powerful marketing tool. Used correctly, social media and UGC can increase the museum's marketing effectiveness and revenue.

By adapting UGC into the museum's online marketing strategy, museums can communicate to their audiences more convincing stories than brand photos and videos. Just as travellers trust reviews on TripAdvisor or booking.com as the basis for placing bookings, so does UGC create more trust in the stories being communicated to visitors. UGC carries authenticity, using real people not actors, real feedback not made up reviews, thus making it much more trusted than traditional forms of advertising. Used wisely, UGC engages museum visitors to do marketing on the museum's behalf. UGC costs close to nothing to generate as it is the visitors themselves who create it.

AI-powered visual content marketing platform CrowdRiff published an *eBook The Complete Guide to UGC for Museums* (Gurney, 2019) highlighting how 8 major museums used UGC as part of their successful marketing campaigns. These case studies show how UGC was used at the Royal Ontario Museum to build an online community by tagging #atROM. The Field Museum of Natural History used UGC to promote specific events and, by combining them to specific calls, to action drive ticket sales. The Children's Museum of Indianapolis targets UGC

on Instagram through posting real visitor photos showing them having a good time at the museum. Creating pre-visit experiences aimed at getting visitors talking and sharing UGC is what the Canadian Museum of Nature did. ‘T-Rex Tuesdays’ was a very successful stunt whereby people were sharing on social media video clips of actors in inflatable T-Rex suits going around the city of Ontario. The Denver Art Museum used UGC to show people of all ages enjoying themselves in an art museum which, as research has shown, may be quite intimidating for some. The Los Angeles County Museum of Art (LACMA) successfully experimented with posting UGC on Snapchat in order to showcase their collections. Snapchat posts are very creatively linked to popular references mixing classical art with popular memes. The British Museum has been very effective in using UGC to create discussions around museum artefacts. This creates further discussion about the artefact or exhibition on social media but also creates a great pre-visit experience. The hashtag #myBritishMuseum reinforces the concept that the museum is a personalized and community experience.

A study of user generated content in the form of travel photographs published on social media showed that these can be used to help examine museum visitor experiences (Vu et al., 2018). Another interesting study, using a technique called topic modelling and carried out on 22,940 visitors generated reviews written about 88 London museums, showed that museum visitors were very much affected by ancillary museum services such as queuing times, entrance costs, toilets and food service. The study showed how visitors look at museums as alternative leisure venues and activities. Such visitor insights are extremely important in order to improve the overall visitor experience.

It is also clear that not all museums have embraced the idea of user generated content. In fact, one still finds many museums where any type of photography is strictly prohibited. Whilst

one understands that flash photography can damage paintings and other artefacts, not allowing visitors to share their experience with their friends and the outside world on social media is clearly counterproductive.

2.4.8.4 Apps. Many museums are now opting to have some form of app to cover part, or all, of the museum visit (Filippini-Fantoni et al., 2011). Since the absolute majority of visitors nowadays have a smart phone, and most sites offer free internet connectivity, it is often argued that mobile apps are a very feasible alternative to traditional multimedia audio guides. Smartphones have the potential to reach new audiences, by delivering information through a device chosen by, and familiar with, the audience themselves. Smart phones can reach these audiences not only during the museum visit but also before and after. Smartphones and mobile apps have the potential to reach audiences in an environment of their choice thus opening up many new opportunities for extending the museum visit - edutainment, lifelong learning and cultural marketing (Economou & Meintani, 2011). The connected nature of mobile apps means that the one to one communication between museum and visitor can also be extended to bigger networks of users with similar interests and shared on social media. Given the increasing use and adaptation of mobile apps by museums there is a lot of discussion going on about the technical issues related to mobile apps in museum use, but this discussion needs to be extended to analyse its effect on the museum visit. Technology will continue changing rapidly but understanding the core principles of how such technology affects the visitors' relationship with museums, cultural heritage and lifelong learning is crucial. As is the case with all other digital tools, implementing a mobile app requires a lot of careful analysis not only of the technology available, but also of the site-specific requirements.

In a paper describing the creation of Malta Culture App, an app for the Malta Tourism Authority, the authors describe the process and considerations required to design the app. A number of facts need to be taken into consideration when deciding to produce a mobile app. Responsive web design has made huge improvements in the way websites appear and reshape themselves on different mobile screens. The first decision which is often determined by budgets is whether to go for a mobile friendly website which looks very much like an app or a proper mobile app downloadable from the two main app stores. If a mobile app is chosen, one needs to decide whether the app should be coded as a native app (specifically coded for each of the different platforms, android, iOS, Windows) or else if it's a hybrid app, coded as a single app that works on all platforms. Each has advantages and disadvantages related to app speed and performance, functionality, development time and cost.

Sometimes apps fail because the content that goes into the app is not planned well. Some apps which include a lot of video and audio may be quite large to download. Apple store puts a restriction on apps which are bigger than 20MB, such that these kinds of apps can only be downloaded via a WiFi connection and not mobile data. This may be a very big limitation and would require the site to provide free WiFi.

Whilst reviewing Castel Sant' Angelo in Rome, visitors, including myself, were unable to authenticate themselves to the site WiFi in order to download the free app which came with the entrance ticket. The app was not available via 3G download and in the end, like many others, I gave up and proceeded to visit the site without the app installed.

Content maintenance and update frequency are another consideration which needs to be carefully analysed when deciding to go for a mobile app. Core app updates especially for iOS can be quite

tedious and time consuming and cannot be pushed in a short time. Content updates also need to be carefully studied especially if content is being “pulled” from the web.

There are 5 main content types each one of which has its particular limitations and considerations when used in a mobile app. Text is the most basic of content types, yet people using mobile apps are not interested in reading long never-ending articles, due to both time and screen size. Just like web content writing, text for use on mobile apps has a certain style. Image use is necessary to illustrate content. For example, text users will not be able to appreciate detail due to screen size unless they stay zooming in each photo. Very high resolution photos increase file size and may cause the content to increase significantly without achieving any major benefits for app use to the user. Audio such as podcasts as well as video add a lot of interesting content to the app, but come at a price. These types of datafiles are quite large in size and need a very good connection to be played smoothly. While visiting the Galileo Museum in Florence, App 3.5.2, I discovered that the museum offered a very good WiFi connection which allowed the download of videos as explanation of the various exhibits and of the concepts discovered by Galileo. The last type of content often included in apps, especially those related to cultural tourism, is the use of maps with their thorough services such as OpenStreetMaps.org or Google Maps.

2.5 Digital Tools to Improve Museum Accessibility.

As Museums transition into the 21st century, the emphasis on Community outreach, inclusion and accessibility of learning to all have become the main focus of museums. Museums are turning to digital tools and new technology to become more inclusive and accessible. Regarding accessibility, the traditional approach was the installation of ramps and lifts to allow wheelchair access into the museum. The concept of extending accessibility has developed further and technology is helping to allow many more people with disabilities to enjoy museum experiences. For a museum to be truly inclusive it is important that the way it communicates with visitors is as effective with people with special needs as it is with those without.

The *State of Museum Access 2018* is a report prepared by 3 organizations, StageTEXT, Autisim in Museums and VocalEyes, and looks at making museums in the UK more accessible to people with disabilities (Cock et al., 2018). The report looks at the information found in 1,700 UK museum websites covering access to the museum including directions how to get there, information relating to guide dogs, special resources such as large print, tactile maps, braille didactic boards, audio guides and tours.

The report identifies Museum websites as the primary source of information which visitors with special needs would use when planning their museum visit. However, 27% of all the UK museums websites reviewed offer no access information and the quality of the ones which do varies significantly.

It was used to promote a number of guidelines to help museums review or create online information relating to improving accessibility and join the Museum Access Pledge. The guidelines cover what should be included in the website and how it should be presented.

Different formats such as images, video, VR and audio can all be used to better inform the visitor about accessibility issues prior to their visit to the museum.

The report also looks at what is working well in the sector and offers guidance and advice to museums so as to ensure that more visitors with special needs can have better access to cultural heritage. It is hoped that, as awareness towards museum accessibility for all increases, visitors with special needs will have increased access to art and cultural heritage.

Museum Visitors with Disabilities - Over the years museums have acknowledged mobility impairment as the main form of disability faced by some visitors and have taken measures such as installing ramp or lift access and wheelchair friendly toilets. Yet the range of disabilities experienced by visitors is much wider and museums need to start acknowledging this while acting to reduce barriers for these visitors. The following sections cover some of the main groups of museum visitors with disabilities, and the digital tools which can be used to help them enjoy their museum visit.

Visitors with autism or learning disabilities - Autism covers a wide range of conditions falling under the Autism Spectrum Disorders. Whilst there are no exact figures of autism prevalence in Malta, we can use the indication from statistics in the UK which indicate one of every 100 persons i.e. 1% of the population. The people with learning disabilities can also include people with specific conditions such as people with Down's Syndrome. Appendix APP2.5 lists some tips which can be used to improve accessibility for individuals on the autism spectrum. These tips were used to create Malta's first Autism friendly museum project reviewed in section 3.3.

Museum Visitors with partial or total blindness - Whilst only a small selection of people have full sight loss, the incidence of partial sight loss is quite high. In the UK it is

estimated that 1 in 30 suffer from some form of partial sight loss (Cock et al., 2018)^[10]. Sight problems tend to increase with age, and in an aging population this is bound to be very common.

Audio-descriptive guides - Not all audio guides are suitable for people with sight problems. The content, software and hardware for an audio descriptive guide needs to be designed specifically for these users. The content itself needs to be prepared by professional audio describers who give much more descriptive detail than a normal audio guide which is normally used in conjunction with vision by the people using it. Such guides may also include detailed instructions on how the visitor is to move around to the next exhibit, something that is not normally needed or included with normal audio guides. The hardware used for these types of guides needs to have special embossed buttons with braille numbering to allow the visually impaired person to be able to navigate between one description and another. High tech touch screen based devices or tablets will not work well for such users.



Figure no 2.5.1 - The Tonwelt Audio SupraGuide features a raised braille numeric keypad and a built-in feature that allows visually impaired users to access an available commentary. The technology will either start the narration automatically or allow the visitor to manually access the audio track related to that particular point in the museum.

Source: www.tonwelt.com

Braille signage and resources - Braille has become a very important tool in the lives of many blind people. Over the years Braille has evolved and braille readers can now be connected to computer displays. Braille information signage will allow visitors who know how to read braille to understand better the displays being shown. Implementing braille signage and interpretation is a multidisciplinary project and needs the guidance of professionals in laying out and preparing the Braille signs.

Object handling / tactile experiences - The ability to touch and handle an object allows blind or partially sighted visitors to better explore and understand an artefact. Whilst it may not be possible to allow the public to touch and handle very expensive or rare artefacts, it may be possible to do so with replicas. During one of the site visits at Bode Museum in Berlin, one of the displays involved an enlarged 3d printed Roman coin which visitors could handle and touch.



Figure 2.5.2 - Handling and touching an enlarged replica of a Roman coin at the Bode museum in Berlin.

Source: taken by myself.

Large Print - Partially sighted visitors are able to read large print (the minimum industry standard being identified as Ariel size 16). Museums sometimes have large print descriptive laminated information sheets to allow users to at least get an overview of the hall they are visiting. Carrying around these sheets to each exhibit can sometimes be cumbersome and/or impractical. The use of tablets and RFid readers or scanning of artefact QR codes will allow large print descriptions to be displayed on tablets once the user gets near to the artefact. Digital displays can be used to zoom into digital images of artefacts to view details which would otherwise be very difficult to identify for visually impaired visitors.

Deaf and Hard of hearing visitors.

Audio Guides with volume enhancement - People wearing hearing aids, especially Cochlear Implant devices, are able to connect via Bluetooth to audio guides in order to enhance the volume of the guide itself. Apart from adjusting the volume, the user can even change the tone of the voice.

Sign Language on video film - Sign language can be used to visually explain the audio being shown on audio visual productions. One must keep in mind that every language has its own sign language, and that the sentence construction of sign language does not exactly match the transcribed version of the audio, thus making it a bit difficult to include both on the same screen, especially if the display is small. Interactivity will allow the viewer to choose to have the transcript shown on screen, other sign language or none at all.



Figure no.2.5.2 - Sign language superimposed on a documentary about Villa Francia (at the three villages interpretation centre – Villa Francia) explaining the history of this country residence over the ages.

Source: Taken by myself.

Subtitled Audio Visual Material - Subtitles are often used to help not only the deaf visitor but sometimes even the public in general. These subtitles are often used in places where audio is difficult to understand such as in noisy areas, to help translate into a more common language, .for example English, what is being said by people on screen speaking a local language, or in areas where audio is not appropriate or possible or where multiple sound sources are playing.

Hearing induction loops - Induction loops are most commonly found near ticketing booths but in reality, they can be used anywhere within the museum where there is a voice audio source.

These hearing loops help people to hear voices more clearly above the background noise.

Advances in technology mean that the new hearing devices and cochlear implants come with inbuilt Bluetooth connectivity which allows them to link via Bluetooth to tablet or mobile phone devices.

Case Studies

The following are three examples of how digital technology has been used to make museum learning more accessible to visitors with special needs.

1. “El Prado For all” – Prado Museum Spain
2. The Vlog Project - Whitney Museum of American Art
3. Leicester Castle: using iBeacons to light the way to a brighter museum experience

“El Prado for All”

The Museum del Prado is one of the most active museums in extending accessibility of its collections to users with special needs. Through its engagement programme “El Prado for All” it has created various learning activities and visiting experiences targeting users within the autism spectrum, people with neurodegenerative diseases as well as dementia and visitors with hearing impairments. The museum wanted to create an experience which would allow visually impaired visitors to explore famous paintings notwithstanding their disability. The museum

chose 6 masterpieces which included The Parasol, a version of the Mona Lisa, Velazquez's Apollo in the Forge of Vulcan and Corregio's famous painting Noli Me Tangere (Touching the prado – exhibition, n.d.).

The Prado engaged Estudio Durerro, a specialist printing company from Spain, who manipulated a high-resolution photo of each painting and used a special printing process to add volume and depth to the painting reproduction. The six high quality works, highlighting different painting styles and genres, were exhibited in a special exhibition held at the Prado entitled "Touching the Prado". The visually impaired visitors were able to mentally visualize the painting by exploring the three dimensional images and learning more about each painting using braille didactic info panels and audio guides.

Exhibition curator Fernando Pérez Suescun, admitted that the exhibition faced a number of challenges including convincing the museum director that such an exhibition was needed to help attract visitors who would not normally visit the museum. The success of the exhibition was the result of a multidisciplinary approach between different experts in different fields including art experts, ICT experts, curators and experts from the Spanish National Organisation for the Blind who assisted in making the exhibition as accessible as possible to blind visitors. Visually impaired visitors from all over the world have visited the exhibition and have given extremely positive feedback to the initiative. Following the initial exhibition at del Prado, the exhibition was then moved to a number of museums and galleries around Spain.

The Vlog Project - Whitney Museum of American Art

The Whitney Museum of American Art is an art museum founded by Gertrude Vanderbilt Whitney in Manhattan. The museum focuses on 20th and 21st century American art

including paintings, sculptures, audio visual art and new media. The Whitney museum is known as the artists' museum as it focuses on showing contemporary art by living artists.

The Vlog project is a collection of short video films showing museum educators communicating in the American Sign Language (Access programs - Whitney museum of american art.). The team behind each vlog includes deaf museum educators and a director/editor who worked with other educational and media specialists with normal hearing abilities. The main aim of these vlogs is to open up possibilities of cultural and artistic learning to people with hearing difficulties as well as to expand the contemporary art vocabulary of sign language. The vlog also includes Museum news featuring interviews and features on special exhibitions.

The use of iBeacons to enhance the museum experience.

iBeacons - Bluetooth Low Energy (BLE) are small digital devices that continuously transmit a unique ID signal over a configurable range. Just like a light beacon they continuously let everyone know they are there.

Bluetooth 4.0 enabled devices armed with a beacon app can listen and read the beacon signal once in range, and perform predetermined actions such as display an image on screen or play a sound related to that location. The user does not have to manually do anything for the action to be activated; the device will automatically communicate with the beacon and carry out its preset action. This is the biggest advantage of this technology, the elimination of the need for human intervention which is needed with other technologies such as QR.

Between October 2014 and September 2015, Leicester Castle carried out a trial project focused on two great courthouses found in the castle. Beacons were placed in various areas of the heritage building. A beacon App for Android and IOs was developed to communicate

between these beacons and mobile devices. Through this App a series of trails on different subjects was created. Two of these trails were developed as audio guides targeting people who did not want to stay looking at visual information on their mobiles or who are visually impaired.

Standing out from the usual digital tools case studies and implementation projects is GIFT Box (<https://gifting.digital/>), a set of free tools and ways of working, targeted at museums that offer richer more engaging digital experiences for their visitors. These tools are the result of an EU research project funded through the H2020 programme. It brings together the expertise and knowledge of a multidisciplinary team of internationally renowned artists, researchers, designers and museum professionals and is aimed at creating engaging visitor experiences with cultural heritage of the museum design and planning tools which include ‘Visitor Box Ideation Card’, a card game meant to be played with other colleagues to help the museum come up with new ideas of implementing digital tools in museum experiences. This is an ideal tool to be used in the ‘Ideate’ phase of the Design Thinking methodology used for such projects. The purpose of the card game is to help museums generate well thought out, innovative ideas and allows them to demonstrate how they decided that a particular idea is ‘good’ or ‘bad’. The ASAP map is like a road map that helps museums planning to introduce a digital experience by enabling them to build on what they are already doing. The map is an ideal discussion tool for the multidisciplinary team. The Experiment planner is another design and planning tool by GIFT Box meant to help museums test new ideas and identify ways how to develop them. Eight different digital tools have been created, developed with and for museums combining physical and digital. These hybrid tools are meant to create personalized museum visitor experiences. GIFT allows visitors to use their tablet or smart phone to create a digital gift very much like a

mixtape made up of objects from the museum. This allows visitors to share their museum visit experiences with someone else, a friend, a relative, a partner and gift them with a personalized museum experience specifically created for the other person. *Never let me go* is a web app tool aimed at fostering introspection through a fun and playful experience. Two visitors play together through their smartphones by guiding each other through a series of questions and prompts in art galleries. *One Minute* is a smartphone app that uses image recognition to identify paintings and provide short reflections about them. The app acts like a museum companion, encouraging visitors to reflect on painting subjects or look at specific artwork details. *Emotion Mapper* is an app which guides visitors to exhibits with emotions they are interested in. It allows visitors to reflect on their emotions when they visit a museum and helps them possibly understand what they feel in front of specific exhibits. *ArtCodes* work very much like QR codes but the museum is able to design how these visual markets look. *VRetfacts* is a virtual reality story telling experience. Visitors can explore and touch 3D models of museum artefacts (which have been 3D scanned and 3D printed) and then share stories about them. This digital tool allows visitors to touch artefacts that they would otherwise not have been able to touch. They can connect and better understand that object through their own personal stories. *ScannerBox* enables museums and users to create and share 3D models of objects in the museum's collection. The digitized 3D models are far more useful than simple 3D objects and can be seen and shared on practically any platform.

2.6 Designing Museum Experiences

Contemporary museology places the visitor at the very centre of the museum experience. Everything that happens within the museum is focused on the visitor rather than just on the artefacts. In this visitor centred approach the design of the museum experience becomes of paramount importance. In today's technologically connected world Museum Experiences are not limited to the physical visit within the museum, but extend also to the virtual world. Museum experience design brings together experts from various fields who need to work together to create a positive visitor centred experience that leads to constructivist learning. The important role played by digital tools has made them an integral part of any museum experience.

In his book *Designing Exhibitions; Museums, Heritage, Trade and World fairs*, British exhibit designer Giles Velarde (2017) shares his extensive experience in commercial and non-commercial exhibition design. This is more of a practical handbook that covers most practical aspects of design and philosophy when implementing an exhibition whether it is permanent or temporary. It is full of innovative and interesting ideas and applications all backed by examples and case studies of past exhibitions. Its down to earth style of writing, concise and free from pedantic jargon, and its practical approach make this a very useful reference book to refer to when planning exhibitions.

Whether designing a permanent or a temporary exhibition gallery in a museum, a trade show or a world fair exhibition, designers face similar challenges related to space, attention and information. The exhibition designer is the jack of all trades who, apart from making use of his specialization in the subject, understands and brings together other specialists and uses the right

techniques to create exhibitions that make the visitor experience a positive one for the widest audience possible (Velarde, 2017).

Museum visits can fall anywhere between two extremities, at one end magical experiences and at the other dreary drudges. In today's world museums can no longer assume that visitors will come to visit them. In the current highly competitive world, museums have to work hard to persuade visitors to visit and spend money within them, and those who are persuaded expect to find a magical and entertaining experience at the museum.

Velarde explains that, whilst many museum halls meet the basic display requirements, many lack the magical experience, turning them into very sterile halls. The author compares a museum exhibit to a commercial exhibit in a trade show. Both are there to sell. To be able to do this, they must attract and inform the visitor to convince him or her to want more. Museum exhibits need to fulfil these four important functions: to attract, to hold, to inform and to persuade

Museum exhibitions, whether temporary or permanent, need to sell themselves or else will become pretty useless if no one visits them, spends some time visiting, learns something new and leaves the exhibit enlightened. All museum exhibitions deal with information, objects, people and space. Museum designers have a lot to learn from commercial trade show design since both deal with the same processes. Digital tools are tools which are available to the exhibition designer who can use them to create more effective visitor experiences. In order to use digital tools effectively, the exhibition designer must understand the factors and challenges which influence the visitor experience. Design should be a thoughtful process and a good designer is an acute observer and understands people.

According to Velarde, “form follows function”. Style, colour, taste, shape, tone, decoration and form are manipulated into one output which is function design. It is commonly accepted that many people believe that, once an object performs its function well, then it will also have intrinsic beauty. On the other hand, function can only be properly executed if the designer has carefully thought about the problem’s solution. Good design is not simply his personal expression of style, tastes and personality.

Designing a museum exhibit involves a lot of interaction with different specialists. A good designer needs to bring together and work closely with curators, light engineers, sound specialists, carpenters, showcase producers, graphic and multimedia artists, technicians, marketing experts as well as bureaucrats.

ICT dominates all aspects of exhibition design. Very often design itself is natively generated on a computer. Modern museum exhibit design uses 3D simulations, virtual display mockups, walkthroughs and audience simulation models. In today’s museum design, computers control most aspects of the exhibition delivery. They control lighting, multimedia, interactive displays, access monitoring and much more. Yet, in the end they are just tools and on their own do not create effective exhibition delivery. Only by understanding and integrating them in the whole design process do they become effective tools.

The book looks into the historical evolution of different types of exhibitions including world fairs, tradeshows and heritage and science centres as well as museum displays, art galleries, and travelling exhibitions. Another very interesting section in the book is a chapter dedicated to The Exhibition Designer. From a very practical point of view, and counting on his own experience, Velarde considers the characteristics that make a good designer. I found this section particularly interesting as it directly relates to my own career aspirations. The

multifaceted skills approach needed by a designer make him the ideal person to bring together the different team members in an exhibition design project. Some of the personal characteristics that make a good designer include being a problem solver, showing intelligent interest in the exhibition's topic and loving communication. An understanding of interior design, structural engineering, graphics, lighting, photography and videography and electronics are handy skills when one needs to understand and work with the other related experts. Given the importance of ICT in all aspects of the project, a very good understanding of digital tools has become a core skill requirement of exhibition designers. The exhibition designer needs also to be a good manager in order to manage and execute projects on time and within a budget as well as a good marketer to ensure that the final product reaches the potential visitor. Velarde explains that technological advances have made some museum exhibition techniques become obsolete and completely replaced by new ones. This is also a very relevant issue with regard to digital tools. Such tools are bound to change and develop in a very short period of time, yet the principles of good exhibition design remain, irrespective of the tools being used. Museums must also realize that exhibits, particularly permanent ones, will get dated with time no matter how modern and state of the art the tools being used are, and, for these exhibits to remain attractive and useful, they need to be kept up to date and refurbished regularly.

“Designing Exhibitions” is interesting because often museums are not very good at selling themselves. Whilst there have been some excellent case studies of success stories, there have also been many failures and underperforming exhibits, with uninspiring displays and little visitor engagement.

Museums relying on simple static text didactic boards to convey information about artefacts which are completely out of reach often exclude the museum visitor from any actual engagement with the exhibit (Ciolfi & Bannon, 2002). The SHAPE (Situating Hybrid Assemblies in Public Environments) project, financed through the EU's FP5-IST programme, looked at how emerging digital technologies could be used to support and enhance museum visitor experiences.

Computer technology is becoming embedded in most everyday objects which we find around us, moving away from the obvious physical presence of the PC. SHAPE used this reality to create a number of hybrid artefacts designed specifically for target museum users.

Two living exhibitions were created in collaboration with two public museums. Both exhibitions were aimed to do away with passive didactic boards and instead, focus on creating environments which encouraged visitor participation, engagement and interaction as much as possible (Bannon et al., 2005). Some of the deliverables of this project included the creation of the Storytent, developed by the University of Nottingham. Targeted at children, the Storytent combined the tent, always popular with generations of children, with mixed reality. Young visitors sitting inside the tent can interact with 3D computer graphics projected on the side of the tent, thus creating a truly immersive environment. Other deliverables included the creation of an interactive desk which worked by moving keycards across a map to trigger the display of information about museum objects. This information is projected, using a hidden projector, onto the blank pages of a book. Video-tracked flash lights technology was used to allow visitors to use flashlight beams to activate sounds and graphics when pointed at specific areas on walls, posters or other surfaces. RFID technology was used in the Combination machine, which allowed visitors to place physical objects and cards into an antique trunk which would in turn create connections between the different objects placed in the trunk.

The concept of ‘Conviviality’ was used extensively in the book *Tools of Conviviality* (Illich & Lang, 1973)^[10]. Author Ivan Illich describes conviviality as that characteristic which allows individuals not to be mere consumers but as being an intrinsic ethical value that allows individual freedom realized in personal interdependence. In the book *The Convivial Museum* (McLean & Pollock, 2010)^[11] the authors use the analogy of a dinner party to present the different elements of what makes a good dinner party a convivial social event. A successful dinner party is one where people feel that they are welcome and comfortable during their stay, an event where guests can engage and connect in interesting discussions. The same analogy can also be used for museums, where such institutions are expected to find ways to entertain, please and satisfy visitors. Museums need to design visitor experiences which make sense for visitors. Unless this is achieved, it is very easy to end up with museum experiences that bore visitors with little or no visitor engagement, participation and satisfaction. The book then highlights 3 main factors which are needed for a museum to offer a convivial experience. A convivial museum needs to be welcoming to visitors even before they start their visit. First impressions go a long way to make the visitor feel welcome. Directional and clear signage makes it easier for visitors to find their way to the museum. Clear and accessible entrances make the museum open to all. Comfort is a very important element of making a museum convivial for its visitors. Given that museums attract a wide variety of audiences this is no easy task, and it is sometimes difficult to design an experience which is comfortable to everyone. Yet some comfort elements often apply to all museum visitors since they meet their most basic needs. Museums sometimes tend to focus on specific aspects of the ambient creation with elements such as lighting for example, but then tend to forget others, such as seating or presenting an over busy environment. McLean and

Pollock emphasise the museum's social construct where museums need to do more than just bring people together. Convivial museums take social conversation to a deeper level and in doing so create a common interest and involvement.

As Elizabeth Bogle (2013) explains in her book *Museum Exhibition Planning and Design*, (Bogle, 2013) planning, and designing a museum exhibit is no easy task. It is a complex and multifaceted process that brings together all the topics covered in this literature review. Bogle says that "One cannot plan an exhibition without designing it or design without planning it. These two tasks are conjoined, and during the exhibit design process they are so interrelated that they cannot be separated" (p.2).

The above statement may sound obvious but it is not always the case. Sometimes museum management fails to realize the central role that the exhibition designer plays. During the design of the Money Gallery at the Mdina Cathedral Museum (refer to Appendix – APP 4.1), the museum's board struggled to accept the role of the exhibition designer. The introduction of digital tools as interpretation tools in museum displays is also another source of confusion. Small museums, due to lack of technical resources and lack of understanding of exhibition design, sometimes pass on the whole exhibit design to the subcontracted IT service provider as an isolated service rather than as a player within the project team.

Designing a museum experience, be it a hall redesign, a temporary exhibition or a museum wide experience requires a lot of research, by the whole project team, not only on the subject matter but also on visitor expectations and understanding. The two case studies in the appendix APP3.5.14 and 3.5.15 show the research done as well as the site visit reviews for the British Museum and Ashmolean Museum's Money Gallery. This research together with the

review of the Museo del Risparmio in Turin were carried out as part of this research and to help the Mdina Cathedral Museum plan the redesign of their own numismatic collection.

2.7 Design Thinking Methodology

Innovation is recognized as one of the principle driving forces behind growth. Countries that embrace innovation usually fare much better than ones which do not (Grossman & Helpman, 1991). Museums are looking at innovation as the key to help them adapt to major changes affecting the cultural heritage sector. The three main areas where innovation is happening in museums are; (i) technological innovation in museum-visitor experiences, (ii) museum management and (iii) organizational innovation. Innovation is fueled by the insights gained through the understanding achieved from observation of what visitors want and need.

Design Thinking, described as a methodology, a culture and even a philosophy, is a system that ensures all forms of innovation activities are inspired by a human-centred focus (Vicente et al., 2012). It is an approach that uses creative problem-solving as a driving force for human-centred innovation (Brown, T., 2008). John E. Arnold was one of the first authors to write about *Design Thinking*. In his *Creative Engineering* seminars at Stanford University, he identifies four particular outcomes of design thinking. These include: (i) Novel functionality-relating to innovative solutions for old problems or solutions for new needs, (ii) improved solution performance levels, (iii) reduced production costs and (iv) improved profitability (Kelley & Kelley, 2013).

Design Thinking was introduced in 2005 at Stanford University, Hasso Plattner Institute of Design, which is commonly known as the d.school. In *Theoretical Foundations of Design Thinking* (Clancy, 2016) one finds an overview of the historical development of Stanford University's design thinking programs starting from the first innovation curricula of creative

thinking, visual thinking and ambidextrous thinking that shaped today's Design Thinking methodology.

Design thinking is spreading worldwide in many different sectors that require innovation. More educational institutions, appreciating the positive benefits of this methodology are implementing it in their curricula, some following the University of Sanford and Potsdam's d.schools in implementing their own design thinking schools. Design Thinking revolutionizes the way people, companies and organizations look at innovation. The process of innovation becomes truly dynamic, continual, reflective, detectable and, most importantly, human centred. Those organizations that adopt design thinking as the fundamental catalyst of their innovation process will be able to sustainably and continuously design completely new processes, services and products (Von Thienen et al., 2018).

Design Thinking for Museums

In the last decade museums have also started using Design Thinking to help them innovate the way they manage themselves and communicate their collections to visitors. In fact, the process of design thinking can literally be applied to any setting, challenge or problem within the museum.

Design thinking helps museums to see issues as challenges that can be tackled and solved rather than just problems. There are five main steps in the Design Thinking model proposed by d.school. These are (i) Empathize, (ii) Define, (iii) Ideate, (iv) Prototype and (v) Test. A detailed explanation of the five phases can be found in the appendix APP2.7

The Design Thinking process is not a linear one and the five different stages are not always sequential, the different stages may sometimes occur in parallel or be repeated iteratively.

Rather than sequential steps, each phase must be understood as a component or node that contribute to a successful development process of innovative problem-solving design. Each museum design project will be different but the Design Thinking process identifies the 5 different stages of development that need to be carried out. Design Thinking methodology was used in the development of the #MeetDurer project developed as part of my research.

Three case studies highlighting the use of Design Thinking methodology are being referenced in the Appendix section App.2.7. The first case study relates to the redesign of the audio guide experience being used at the Museo Egizio (App 2.7.1a), one of the museums I visited and reviewed as part of my research. Another case study covers a game design project for The Children's Museum in Indianapolis (App 2.7.1b), whilst the final case study covers a web development project for the Getty Museum (App 2.7.1c). These three case studies show how this methodology was used in the implementation of 3 different digital tools in three different museums. They clearly demonstrate the various advantages offered by such a methodology including tackling innovation from a multidisciplinary team approach, the importance of approaching projects from a visitor centred point of view, the power of prototyping and how testing becomes a built infection of any project being introduced in the museum.

3. Methodology

3.1 Research Methodology

“Museum of Innocence” (Pamuk, 2010) was one of the very first books suggested by my tutor at the beginning of my research for my Masters degree. This novel, by Turkish Nobel-Laureate Orhan Pamuk, tells the story of Kamal, a well-off Turkish businessman and Fusun a poor distant relative of his. Kamal falls in love with Fusun even though he was engaged to another girl, Sibel. After their initial intense affair, the two are separated after Fusun leaves following Kamal and Sibel’s engagement. During the time they are separated, Kamal who cannot stand the pain brought about by the loss of Fusun, tries to find consolation through objects and places that remind him of her. A year later Fusun agrees to meet Kamal but she’s now married. They keep in touch for around eight years during which time Fusun gets divorced and agrees to marry Kamal. After a long trip around Europe just before their marriage, the two get separated for ever. Kamal converts Fusun’s house into a museum housing all the different objects and memorabilia collected during the time he had known Fusun. Apart from finding it a very good novel to read, I was intrigued by the fact that the author actually set up a physical *Museum of Innocence* based on the museum mentioned in his novel in a building in Istanbul. Both the novel and the museum itself continually refer to the topic of museums and collections. Pamuk later published an essay entitled *A Modest Manifesto for Museums* (Pamuk, 2013) where he expressed his belief that, to remain relevant, museums need to become more focused, even smaller and more efficient. Reading Pamuk’s work was a very important starting point; it framed my research, enabling me to look at the general picture of museum visits rather than to focus simply on the tools themselves. Another important museum which exerted a considerable influence on my research

was the “Museum of Broken Relationships”. This “museum” started off as a travelling collection and later found a permanent location in Zagreb. In 2011 the museum was recognised as Europe’s most innovative museum (Vistica & Grubisic, 2017). Founded by two artists – film producer Olinka Vištica and sculptor Dražen Grubišić, the museum was the result of their own four year relationship breaking up in 2003. The museum contains a collection of everyday items donated by people from all over the world related to their own broken relationships. This museum is one of the most popular museums in Croatia. Like the Museum of innocence this museum is all about the strong personal narrative, the emotions and feelings of the protagonists and how all these relate to the visitors. 80% of visitors to this museum on Trip Advisor rate their visit to this museum as excellent or very good. Reviews of the museum are extremely interesting because they clearly show that the visitors could identify the stories showcased in the exhibits with their own experiences. Reading between the lines of these comments offers other interesting insights. Visitors said how they spent much more time reading the stories next to the objects on show than they would normally spend at other museums. Others said that whilst they would normally walk through museum halls and only stop to look at one or two objects that catch their attention along the way, they took their time within this museum and read practically all the captions.

These two museums are extremely relevant to my research, as they made me realise that the research should not focus simply on the use of digital-tools for improving the visitor experience. The digital-tools are not some form of magic pill that suddenly improves the visitor experience. These two museums managed to capture the attention and imagination of people without showcasing priceless artefacts or impressive digital tools. This means that the most important factor at play is understanding what makes the visitor interested in the museum. This is

in line with the new line of thought in museology which puts objects second to the message. Museums with big and expensive collections automatically think they are attractive to customers, which is often not the case. I have visited the Vatican museum many times, the hordes of tourists just walking along like a flock of sheep, understanding nothing and appreciating very little meant they really got very little from their museum experience. I would say the same applies to the Uffizi and to a considerable extent also to the Louvre. The two case studies above challenge the concepts of what many curators think make great museum experiences. Within this scenario, digital-tools can be used to improve the visitor experience only if they are used well as part of a redesigned museum experience. They are just a means to an end.

This chapter gives an overview of the research methodology and approach which I have undertaken over the last two and a half years to try to understand the role that digital-tools play in the overall visitor experience. I have conducted my research over three particular aspects, with the aim of triangulating my research into a more meaningful, rigorous and trustworthy analysis (Vauillaume, 2015). The three areas of research included practice-led, field research and observational methodologies through: my personal artistic installations which used digital-tools as a way of visitor engagement, on site research at various museums and heritage sites both locally and abroad, and finally a number of museum projects which I used in order to design and test the concepts I was reading about in the literature.

The goal of my research was not to test one specific digital tool but to look at how such digital tools, or lack thereof, affected the whole user experience within museums and cultural heritage sites. The very large number of variables, related to audiences and a multi technology strategy, that were looked at made this research very challenging. I first needed to decide on whether I should go for quantitative or qualitative data collection. The complex forces at play in

understanding a museum visit made a quantitative research approach very limiting in helping me understand different visitor background, motivations, use and adaptability of different digital tools in so many different museum environments. Sometimes even within museums themselves different halls had completely different challenges and requirements which would not have been easily, or meaningfully, analysed through a survey or questionnaire (Queiroa et al., 2017). In “Cathedra”, one of the artistic installations I worked on, and which I shall explain later in the chapter, I initially tried using questionnaires to understand visitors’ reaction to technology, but the answers being given were painting a completely different picture from the more meaningful observational data I was observing. I have observed that in my case, data obtained through quantitative methods is not sufficient to yield in-depth information about museum visitors.

Museum visitor engagement cannot be measured simply by counting the number of visitors walking through the doors. Numbers on their own do not give a realistic or meaningful picture of the visitor engagement within the museum and provide little or no feedback with regard to the visitor’s experience within the museum. Qualitative data is more useful in understanding visitor attitude and feelings (Atieno, 2009). It may offer us a range of different viewpoints such as comments in a comment book, or reviews on social media, or visitor feedback from interviews. Such an approach is much more useful to understand the visitor. In the analysis of museum visitor behavior in the literature review, especially regarding the motivation that brings visitors to museums, as well as in the studies carried out by the Ashmolean (Fritch, 2011) and British museum (Orna-Ornstein, 2001) in their many gallery redesign projects, a qualitative approach, mostly in the form of semi structured interviews, was used. In a study carried out at six national museums as part of the EuNaMus project funded through the FP7 EU framework, qualitative research was used to find out how visitor

experiences could be used to understand how national museums can best help European cohesion and tackle the social issues that challenge European unity and stability (Dodd et al., 2012).

Family research studies are also important since families are a significant component of museum visitors, yet such studies and research are complex, since a wide range of influencing factors need to be taken into account (Commuri & Gentry, 2000). Qualitative research is increasingly becoming the main method of choice for researching family visitor studies and the most suitable to look into museum family learning (Sterry & Beaumont, 2006). Different innovative observational research methods have been used to analyse museum visitor experiences; these include video and audio recordings (Vom Lehn et al., 2002; Gutwill, 2002), interviews, diaries (Sterry & Beaumont, 2006), drawings, photography and personal meaning mapping (Dierking & Falk, 2000).

Based on the above trends in museum visitor research I have focused on observational research as a form of qualitative research to try to understand the visitor experience and the impact of digital-tools in the overall experience. Through this method I could observe visitors and their reactions within the museums I was visiting, the different installations I set up and the museum projects used to test different concepts and ideas resulting from my literature review.

Observational research is an ideal methodology for user experience research. Such research occurs in natural user settings and not in controlled settings. This research is ideal to help understand people's experiences through the way they interact with artefacts, or their attitudes and reactions whilst visiting museums and cultural heritage sites. Such research is also ideal to identify pitfalls and provide ideas for innovation and improvement in the user experience. In his book *Doing ethnographic and observational research*, Michael Angrosino (2007) illustrates the importance of observation as one of the most important methods of

qualitative research. Angrosino makes two significant methodological distinctions as follows: the objectivist approach, which is linked to positivist research, and the researcher's ability to maintain objectivity without influencing the participants, in contrast to the postmodernist approach related to social constructionism, where the researcher becomes part of the creation of knowledge.

There are four main types of observational research roles that can be adopted. In the role of a 'Complete Observer' the participants are not aware of the researcher's presence and observations; this would encourage them to act more naturally thus reducing the Hawthorne effect (Stand, 2000). This kind of observational method is especially suited for public places such as museums and historical sites. Another role is that of the 'Observer as a Participant'. Here the participants are aware of the researcher's goals and the role may also involve some limited interaction between the participants and the researcher with the latter playing a very neutral role in the research. In the 'Participant as an Observer' role, the researcher becomes fully engaged with the participants. A 'Complete Participant' role involves research where the researcher participates with the participants in the research activities. While participants interact with the researcher they are not, however, aware of the research being carried out. The most classical example of this role is mystery shopping or any other activity allowing the researcher to experience the situation first hand (Gold, 1958).

Observational research offers many advantages. It allows the researcher to experience events from the perspective of the participants, permits very detailed description of situations and helps contextualize the data being collected. The best way to understand user experiences in museums is by observing visitors within museums themselves. Constructivist museum learning postulates that museum experiences are made up of a series of interrelated events, before, during,

and after the museum visit (Falk, 2004). Observational research offers a very flexible approach for semi or unstructured research design. Rather than prematurely trying to prove a theory, observational design looks at the general picture through the participants' eyes (Sauro, 2015):

The purpose of the research is to be able to understand the different approaches being taken by museums in engaging and interacting with their visitors in the context of changing museum trends that put the visitor at the very centre of the museum experience. The research would help me understand the complex realities linked with museum audiences, visitor motivations, and constructivist learning. Considering my background as a multimedia designer and museum visitor, and not as a seasoned museum professional, this methodology would help me objectively observe the participants within museums and historical heritage sites.

Based on the insights on observational research methodology highlighted in *Interpreting qualitative data: Methods for analyzing talk, text and interaction* (Silverman, 2006) I prepared a number of questions and research areas which would form the backbone of my unstructured observational research. These were:

- i. What type of audience was present?
- ii. What were the participants doing?
- iii. Were the participants engaged with the artefact displays in the museums or heritage sites?
- iv. Did the museum / site provide an engaging / comfortable setting for visitors?
- v. Were any digital-tools available and how were they being used?

My research efforts can be grouped into 2 main sections: a) creative works and museum projects and b) EU funded COST Actions that have given me access to international expertise, peer discussion and international museum practice. Both research areas are in parallel to each other and they mutually inform each other thus helping me build a deeper and better understanding of the overall research.

3.2 Creative work and Museum Projects

As part of my research I designed two creative installations “Solitude” and “Cathedra” both meant as practice-led projects that were also used to test the visitors’ reactions when exposed to experiences which included digital tools. These two installations are an example of the practice-led approach which I have adopted throughout my research.

My first creative installation entitled *Solitude* was tested with the public during the Easter of 2017. The purpose of this installation was that I wanted to test how people would react to using a large touch screen to navigate a virtual tour, essentially two digital-tools in one. The inspiration for this multimedia installation came as a result of personal circumstances which gave me the chance to read a lot about solitude and loneliness, especially the works of Cardinal John Henry Newman, now declared Saint.

Solitude looks at the difference between loneliness, which is marked by a sense of isolation, and solitude, which is a state of being alone without, however, being lonely, and can lead to self-awareness. From the outside, solitude and loneliness appear to be very similar. Both are characterized by solitariness. But all resemblance ends at the surface. Solitude is a time that can be used for reflection, inner searching, growth or enjoyment of some kind. Deep reading requires solitude, so does experiencing the beauty of nature. Thinking and creativity usually do too.

The setting of this art installation focused on the two states. An illustration of these two states can be found in the Holy Scriptures in the scene from the passion of our Lord in the New Testament, when Jesus Christ stood in the Garden of the Gethsemane praying and meditating on His own passion. Here even the Apostles, his most trusted and beloved friends, abandoned him

and as a Human he felt lonely. Yet this was followed by solitude where in the quiet of the garden he reflected on his life and what was to come.

He spoke to His father as He highlighted the purpose of His mission of salvation which would be accomplished by His passion. This biblical episode is commemorated every year during the Holy Week, specifically on Maundy Thursday. Maundy Thursday is the eve of Good Friday and in Malta this feast is linked with an old tradition whereby the faithful visit to seven churches is carried out to pray and meditate on the passion of our Lord. On the day, the Holy Eucharist is placed in an ornamental altar of repose, known as the Sepulcher. Some of these Sepulchers, such as the one at the Mdina Cathedral, are highly ornate Baroque structures, hundreds of years old. For Maundy Thursday these altars of repose are beautifully and richly decorated with a quantity of flowers, usually white, and candles.

Through my installation I wished to challenge these ornate setups and instead create an immersive experience using primarily digital tools. Instead of the highly decorative setup, flowers, and lights, I wanted to recreate the ambience of the garden of Gethsemane, where visitors could pray with Jesus represented in the exposed Holy Eucharist. To achieve this immersive feeling, I wanted to use projection on four walls and surround sound. The projection would screen scenes of an olive grove very similar to the one I had seen when I visited the Mount of the Olives in Jerusalem. Multichannel sound recordings would further enhance the immersive experience by projecting sound from all corners of the room, exactly the way you would hear sounds if you were in the garden in the middle of the night. I decided to combine the multimedia installation with a real exposition of the Holy Sepulcher, open to the public within a church during the Holy Week.

Choosing a location for this installation was not easy since the Catholic Church has very strict rules where the Sepulcher can be set up and displayed. Moreover, Sepulcher setups in many churches in Malta date back hundreds of years and few would want to experiment with new artistic layouts. The Jesuits accepted to host, in the chapel of "Our Lady of the Wayside" in Naxxar, my installation instead of the usual Sepulcher.

Through this installation, I set out to discover how audiences reacted to the use of digital tools replacing traditional displays. I was very interested to find out whether such an installation would enhance or distract audiences' attention from their prayers during the traditional visits to the Sepulcher, known locally as the "Seba' Visti". This would be a live experiment. Due to budget restrictions I had to cut down on the number of projectors used and instead focused on just one big 4K back laser projection behind a very minimal Eucharist stand. A huge screen was built using trusses. The rest of the room was completely blacked out with the only light coming from the black and white projection and just a few candles in front of the Eucharist. The sound system used a HEOS AVR 5.1 wireless 4K sound receiver, creating exceptional quality and clarity.

The installation was open for about five hours on Thursday afternoon and five hours on the morning of Good Friday. During these ten hours, hundreds of visitors came to pray in this chapel. I sat at the very back of the chapel observing people praying. I immediately noticed that, even though the chapel was at times packed, there was no talking or noise. Everyone was praying silently or very quietly in case of a group. I could see people with their eyes closed not even looking at the projection but clearly contemplating and meditating. The priest in charge of the chapel said he was impressed by how long people were taking to recite their prayers. What was sure was that it was not the elaborate sepulcher which was keeping them longer since the

installation was very minimalistic. The ambience carefully created on the basis of an understanding of solitude and of the subject matter, worked to create an immersive environment which captivated the audience's attention. I also waited outside the venue, and spoke to people coming out of the chapel asking them for feedback. The common consensus was that this sepulcher created a much better ambience to meditate and pray than did the traditional highly decorated ones. Many felt that the installation enabled them to imagine being in the garden with Jesus and the created environment was much more conducive to personal reflection.

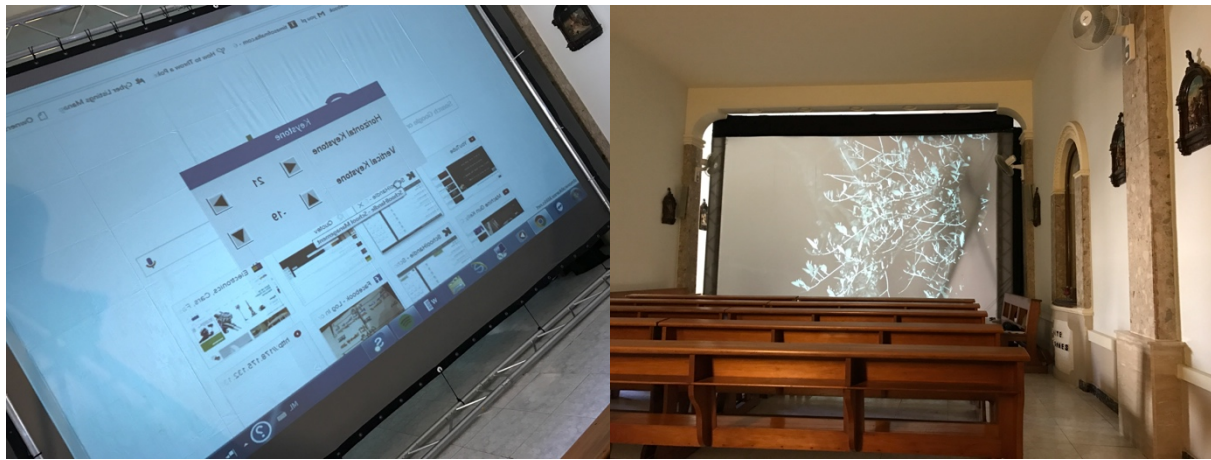


Photo showing the large screen, stretched over a truss frame covering the whole width of the chapel, and a back projection from behind the screen was used to project the video of the Gethsemane garden at the foot of the Mount of Olives.

Source: Taken by myself.



Photo showing the installation setup. During the installation the chapel was shrouded in darkness, and an immersive experience was created using ambient sound and large-scale projection.

Source: Taken by myself.

MFS exhibits during Notte Bianca

As students reading for our Masters degree at the Department of Digital Arts, we were invited to set up exhibits that reflected our work during the Notte Bianca event held in October 2017. The Notte Bianca event in Valletta is one of the most popular national events attended by thousands of people from all walks of life and our exhibition was to be held at the old University campus in Valletta. Through this installation I wanted to observe how visitors, without any training or instructions, would react when using a multitouch interactive screen to browse an immersive 360° virtual tour.

My piece was entitled *Cathedra* - referring to the Mdina Cathedral, which, as the seat of the Archbishop of Malta, is considered to be the most important church in Malta. I wanted visitors to explore the inside of the cathedral without physically entering the cathedral itself. This

I achieved through the creation of a 360° virtual tour of the inside of the cathedral. The virtual tour was based on a number of hotspots using 360° photos. Users could explore and navigate from one area of the Cathedral to another simply by clicking on these hotspots.



The above two screen shots from the interactive virtual tour show the immersive feeling that the viewer would experience of the inside of the cathedral. Unlike traditional 2D photographs, the 360° experience allows the viewer to interact with the photo, turn the viewing point in all

directions, as well as zoom in and out, thus enabling the smallest detail to come to life. As background music to the interactive tour and in order to further place the visitor into a more sensorial experience, I used an original recording of a musical and choral performance of the “Kyrie Eleison” recorded within the cathedral itself.



Photo left: Projections of the paintings from the cathedral ceiling onto the barrel-vaulted ceiling of the lecture room.

Photo right: The 42” touch screen with the interactive installation.

Source; Taken by myself.

The installation involved placing the interactive tour onto a large 46inch multitouch interactive unit. To enrich the ambience of the room, which was very dark, I projected large pictures of the painted ceiling of the cathedral onto the ceiling of the old lecture room. This enhanced the feeling of being within the cathedral. On one of the walls I also put up a video with a short artist’s statement and an explanation of the work. My plan was to encourage visitors to

use the interactive unit and then, once they were ready, ask them a few questions about their experience of using the touch unit.

For this installation I had planned to use a quantitative data collection approach by asking visitors a series of questions to find out about their experience of using the multitouch screen, and subsequently compare the results to basic demographic data. A copy of the questionnaire can be found in the Appendix. After the first two hours with around 35 filled in questionnaires, I decided to stop using the questionnaires for data collection. The reason I did so was because I realised that the answers I was getting were not truthful. For example, people being asked if they went to museums would answer they did so regularly especially if they were part of a group, but then could not name a single museum they had visited in the last twelve months. Questions related to ease of use of the interactive monitor obtained answers stating that it was extremely easy to use when in fact I could see that some users were in fact having trouble moving around the virtual tour. I thus chose to put aside the questionnaires and instead stayed in a corner observing users at the interactive screen. The majority of visitors managed to use the system; later some of the older users said it was easy as it felt like they were using their smart phone but on a much larger scale. Visitors who came in as pairs always had a more dominant person who would show the other how to use the unit. Solo users were the ones who spent most time trying out the system, and users often felt they should move along if other visitors were behind them looking at the screen. Some in fact moved on not to let the ones behind them wait too long, but others moved on as they felt embarrassed if they did not manage to use the screen navigation well. The biggest lesson that I learnt from this installation was about the data collection itself. I confirmed that one size fits all questionnaires and surveys did not lead to an adequate

understanding of visitor experiences. The virtual tour of the cathedral can be found here:

<http://www.metropolitanchapter.com/mdina360/>

3.3 Museum Projects

As I was carrying out my literature review and reading about case studies in museums abroad through desk research, I wished I could test these new ideas and concepts especially those related with contemporary museology through real projects. Museums in Malta are either publicly owned and managed by the government through Heritage Malta, or privately owned mostly by the church or Voluntary organizations.

Trying to implement new approaches through Heritage Malta would have been very difficult and slow, since Heritage Malta is a big organisation with very rigid and inflexible decision-making structures. On the other hand privately, owned museums were much smaller in size and some, like the Mdina Cathedral Museum, very traditional and conservative. Privately owned or managed museums had one thing in common, no one had funds for experimentation. Any extra funds would go towards restoration and not to acquire digital-tools for museum experiences.

To be able to penetrate the private museum sector in order to carry out my projects, I managed to successfully apply for and obtain funding through a number of platforms for 3 different organizations, so that they could implement digital-tools and other contemporary museology projects which I would design. As long as I was getting the majority of funds to carry out these projects, these organizations accepted me to carry them out.

The three organizations which I worked with for these projects were the Mdina Cathedral Museum, Din l-Art Helwa and Għaqda Hbieb tat-Tempju. The following are some of the projects

for which I managed to get funding throughout my research to be able to test my ideas. Projects are categorised by the related voluntary organisation.

Din l-Art Helwa (DLH)

DLH is a voluntary organization set up more than sixty years ago, whose aim is to safeguard Malta's cultural heritage and natural environment through the restoration and conservation of built and natural heritage.

Nemo - l-Ahrax White Tower (2017 – 2019)



Torri l-Abjad, Ahrax tal-Mellieha, 1658 – 1715 - 1918

In 2017, Din l-Art Helwa (DLH), a voluntary organization dedicated to preserving Malta's cultural heritage, signed a guardianship agreement with the Mellieha local council, and

was entrusted with the restoration of the White Tower, one of Malta's coastal towers. This tower is one of 13 similar coastal towers built by Grand Master Martin de Redin. Since it was built in 1658, the tower, sited at l-Aħrax tal-Mellieha, has undergone various extensions and modifications by the Knights, by the British army and later by private tenants. Following the hand over, DLH embarked on an ambitious restoration project. In my professional capacity, DLH asked me to apply for funding from the Malta Community Chest Foundation and design a project for the reuse of this historical building.

Following discussions with DLH's executive committee, I designed project NEMO, an educational museum project aimed at exposing children coming from underprivileged backgrounds to cultural museum experiences and environmental awareness particularly related to the sea. It is a fact that children coming from such backgrounds do not normally visit museums and cultural heritage sites. NEMO targets such children who will not only have the chance to visit such a site but will also carry with them positive memories of their visit which will hopefully encourage them in the future to be more open to visiting museums and interpretation centres and to take an interest in the country's cultural heritage.

Although the project's primary beneficiaries are children, clearly, adult visitors will also be able to benefit from the educational experience which will cover marine biology, the Mediterranean Sea, the history of Malta's coastal towers and also the work of Din l-Art Ħelwa over the last sixty years.

The biggest challenge of creating a visitor experience within this coastal tower was that apart from the tower itself there were no other artefacts on display. I solved this dilemma by turning to digital-tools to recreate the learning / visitor experience.

The visitor centre occupies the two rooms and a corridor forming the ground floor of the tower. This area was turned into an interactive multimedia educational zone focusing on culture and marine environment. The available area is very small and would only accommodate a handful of visitors at a time. The brief for the content of the educational programme focused on the cultural and marine environment, with a special focus on those aspects related to conservation and responsible use of the oceans, seas and marine resources for sustainable growth.



Photos above show typical layout of each information zone. Large format graphics provide minimal information which puts the interactive unit into context.

Source: Taken by myself.

I wanted to ensure that the exhibition area would not be overcrowded, full of captions and information. The first room which is the bigger of the two would be the interactive area. Four large boards with very little text but large graphics covered the four walls of the room. At the centre of each board, low profile thirty-two inch interactive touch screen units were installed.

Each of these four zones focused on a particular aspect of the exhibition, these being: 1) Din l-Art Helwa and the preservation of Malta's Cultural Heritage 2) The Coastal Towers of the Knights of Malta 3) The White Tower and 4) Marine Biodiversity.

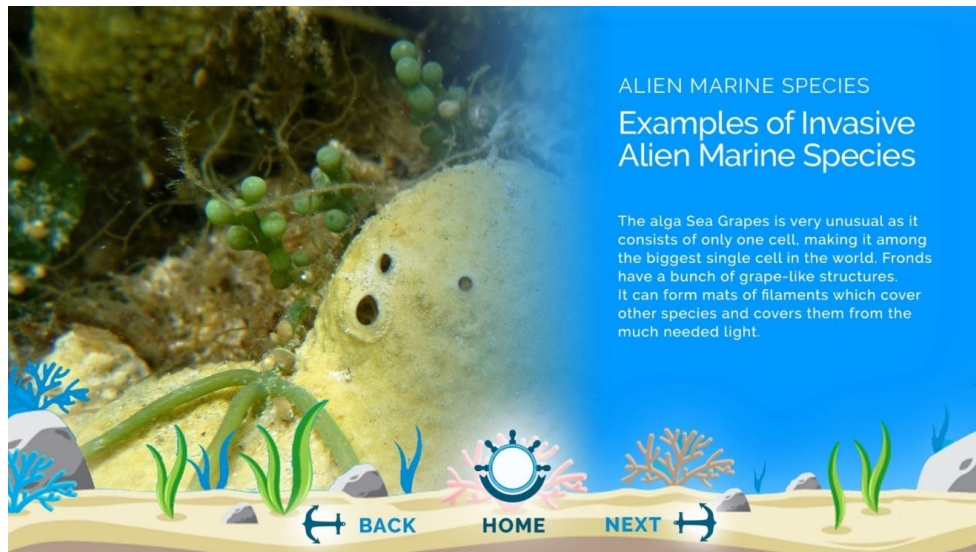


Photo showing a typical screen from the interactive presentations. Menu navigation is very simple. The central button, in the shape of a ship's navigation wheel, takes the user to the home screen of that presentation, where all the sub presentations can be accessed. The two anchors act as back and forward buttons. Source: Din l-Art Helwa



Photos above show children using the different interactive screens. The menu navigation was placed towards the bottom end of the monitor so that it could be reached by everyone.

Source: Din l-Art Helwa.

Fully aware that the main audience of this exhibition area would be children, I wanted to ensure that the content navigation would be very easy to use and fun. The touch screen content was designed with very colourful graphics having an underwater theme. Menu buttons were in the shape of air bubbles and all placed at the lower part of the screen to ensure that everyone could reach the menu. Careful use of the menu system ensured that a lot of content could be packed into these units without making them difficult to use. Intuitive multilayer navigation ensured that the user never felt lost whilst browsing the content. Since the room is quite small no sound was used as this would create interference if more than one screen was being used at the same time.



Photos above show children crowded round the interactive game “patiently” waiting their turn. The game levels are specifically designed to be quite short lasting not more than one minute to avoid bottlenecks.

Source: Din l-Art Helwa.



Screen shot of the “Clean the sea” game.

The objective of this game is to fish out rubbish from the sea.

In the centre of the room, I designed a simple but fun game for children. The aim of the game is to pick up waste from the Gozo Channel. Graphics were customized to show the White Tower in the background and the Gozo ferry crossing from Gozo to Malta. The game was placed on a large multitouch interactive screen.

In the connecting corridor between the two rooms, I designed a large graphic showing the use of the White Tower as an underwater hydrophone station. Since the area is small, I could not use any interactive units as people using them would have blocked the entrance to the anteroom, yet I still managed to find a digital tool which could be used to enhance the visitor’s experience. In order to achieve this, I installed a small speaker emitting the bleep of a sonar similar to what the hydrophone operator would hear.



Photo left: showing two information zones and the corridor leading to the multimedia room. Photo right: showing a big screen with looping documentary.

The inner room was designed as a small multimedia room, where a documentary was created about marine biodiversity and the foreshore. Bean bags were used to create a more informal setting for visitors watching the documentary.

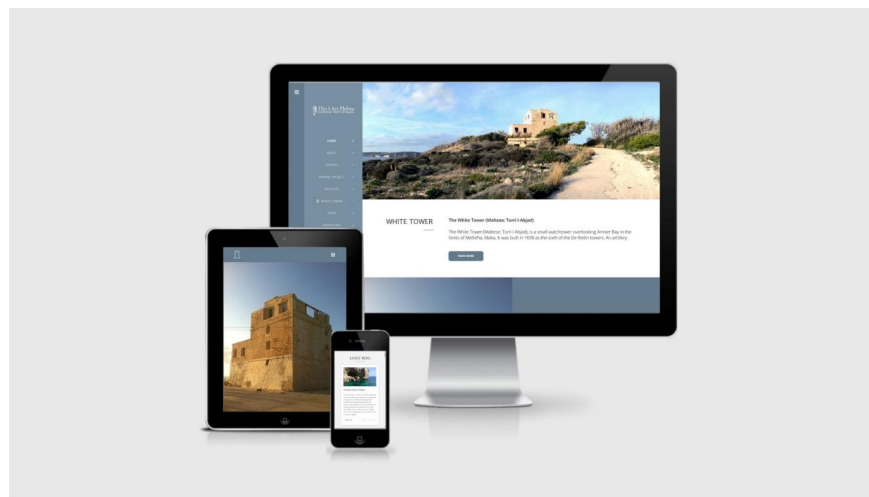


Photo above: showing responsive website for the White Tower, Mellicha

Source: Taken by myself.

As part of this project a website dedicated to the White Tower project was created (<https://whitetower.dinlarthelwa.org/>) allowing visitors to plan their visit to the White Tower. During the scholastic year starting October 2019, schools were able to book their visit by sending a request to DLH via the website. Teachers were able to receive beforehand a brief of the educational material to be used during the visit.

The Nemo experience was opened to school children in October 2019. The first groups of primary school children were extremely receptive and excited about using the interactive screen and especially the game. Observing children use these interactive units offered clear evidence of their ability and the extreme ease with which they immediately made use of the available interactive technology at such a young age. This can be attributed to the fact that children are digital natives and completely at ease with such technology. It also reflects the fact that a properly designed interactive experience does not create barriers to usage but rather provides an effective tool to communicate with and engage audiences. I could also observe that digital-tools were keeping children engaged and interested in topics which might have been difficult to explain and to get them to engage with without digital tools.

Ghaqda Hbieb tat-tempju - Birkirkara Basilica Museum

The “Ghaqda Hbieb tat-Tempju Sant’Elena” is a voluntary organization engaged in creating a museum dedicated to the Basilica of St. Helen in Birkirkara. This small organization approached me to design a visitor experience covering the museum, the Aula Capitularis and the Basilica itself. The project allowed me to contribute ideas and approaches that were not simply limited to digital tools, but saw digital tools being used as part of the overall visitor experience.

This interesting project presented various challenges, among which the limited exhibit area, the wish by the VO to exhibit as many artefacts as possible, and the challenge to create an interesting visitor experience not only for the inhabitants of the town but also for visitors from outside, including foreigners who would not be familiar with the customs and traditions of the locality. The biggest challenge was funds. Being completely funded by volunteers with no major financial backers, the museum managed to achieve miracles with the limited funds available. Designing the museum when it was still essentially a blank design sheet, an open space ready to be developed, allowed me to design it from the visitor's point of view. Various onsite brainstorming sessions covered topics focused on three basic questions: What did the museum represent? What was the message that the museum wished to convey? Who were the prospective audiences?

These discussions allowed the team responsible for developing the museum to take a more visitor focused approach in every decision that was being taken. My role as exhibition designer within the team involved explaining the latest contemporary museology principles, particularly that of putting the visitor in the centre of the experience and encouraging discussion. Enthusiastic volunteers working on this project realized that the museum was not simply a showcase of the artefact they had so lovingly restored and conserved. The museum had a strong message of local identity, a narrative going back hundreds of years, a rich history waiting to be heard, personal stories waiting to be told about one of Malta's most important localities. Although the team was not made up of experts, the involvement of different highly dedicated volunteers, a structured discussion and the pooling of ideas from different individuals and points of view made this a very positive and highly rewarding exercise.

Through these sessions we agreed on a name and a mission statement for the museum, and on a common approach in the message and narrative throughout the different zones of the museum. We discussed the style to be adopted throughout, the colour schemes, lighting, didactics, labelling, and displays. This team approach had many advantages and proved to be a great asset to decision making. Discussions encouraged the designers to look at exhibits from different points of view, to accept different realities related to audiences and to manage expectations with respect to budgets.

One of the most interesting discussions we had was related to the implementation of digital-tools within the museum. The team strongly believed that introducing digital interpretation tools in the visitor experience would add value to the museum. My role was to explain that digital tools were merely tools and decisions to include any form of digital tools should be guided by the visitor museum experience, the expected audiences and making the best use of the available but highly limited budget. I was successful in application for funds from different sources including the Small Initiatives Schemes (VOPs), Voluntary Organisations Projects Scheme and the Ministry for Tourism. Three different forms of digital tools were included in this project.

In order to contextualize the museum, we created an introductory multimedia area which would use a short multilingual documentary that gave an overview of the locality of Birkirkara, its development over time and its relationship with the Collegiate Basilica of St Helen. The documentary would allow visitors to understand the link between the two and the impact the Basilica had on the social development of the locality. Following the screening of the short documentary, visitors would enter the museum, where the first information area would put the four distinct zones of the museum into the proper context. Media looping screens and large graphical didactic boards about each of these four areas help the visitor understand the narrative behind each zone. The storytelling aspect of these screens is very important as, rather than simply describing the artefacts, it is meant to speak about the people, the communities and the society of Birkirkara and why the artefacts exist. This is similar to the thematic approach taken by the British and Ashmolean Museums in their Money Gallery displays. Rather than simply providing information on the individual coins, these museums tied them with narratives such as trade, power and store of value. Artefacts as part of storytelling can also be seen clearly at the

Mole Museum of Cinema, where artefacts are used to describe the development of cinema as a mass communication medium throughout the ages. Such an approach will give a much richer visitor experience, allowing visitors to the museum to understand the stories behind the different artefacts. Once visitors start exploring the museum, they can make use of audio guides that give a detailed explanation of the different zones as well as information about the different artefact again linked to a narrative that explains the relevance of the particular artefact within the overall context of the museum. Once outside of the museum area, visitors can continue to explore two important areas within the complex, the Aula Capitulare still used by the Basilica's Chapter, and the Basilica itself. This approach helps the visitor to understand the different links between the locality's traditions, history and religion as showcased in the whole complex. The museum here takes the role of an interpretation centre, helping visitors interpret what they are seeing in both the museum and the Basilica.



The above photo shows a panoramic view of the museum. On the right hand side is the multimedia area which acts as an introduction to the museum.

Source: Taken by myself.



The above photos show artefacts from two of the zones within the museum, the left hand side dedicated to paintings and the one on the right dedicated to the silver collection. Visitors to the museum will find information about each zone via the introductory information area, and detailed explanations via the audio guides.

Source: Taken by myself.

The museum is set to open in the second quarter of 2020. Whilst most of the exhibits are in place, the documentary, audio guides and media looping units, at the time of writing, are still under production. A huge emphasis was placed on the content rather than just the hardware of the digital tools themselves.

Mdina Cathedral Museum - “MuseumAccess” and “DressMeUp”

In 2017 the Mdina Metropolitan Chapter issued a tender for the development of a web presence. The Chapter is responsible for the Mdina Cathedral, which, besides being the seat of the Archbishop of Malta, comprises the Mdina Cathedral Museum and the Mdina Archives. The website is meant to showcase the three organizations online. I was contracted to develop the website which was delivered in September 2017.

Whilst working on the website, especially on the section dedicated to the museum, I was highly impressed by the treasures it contained and the huge potential that this site offered. I built a strong working relationship with the Curator Mons. Alwig Deguara and the Assistant Curator Mons. Dr Edgar Vella which allowed me to suggest and propose projects that opened up the museum to the public by putting the visitor at the very centre of the experience. Such proposals were quite radical for a church-owned museum which in many aspects was very traditional. Luckily, both curators (Mons. Dr Vella became director and curator in 2018) were very open to fresh ideas and new trends in museology.

In the Mdina Cathedral Museum I saw a great opportunity to test out ideas related to contemporary museology and visitor access and engagement which I was researching and reading about in the literature. As explained above I would only be able to try out these ideas in a real museum live environment if I managed to get funding to finance them. The literature related to museum audiences especially to attracting audiences who did not normally attend museums, led me to explore ideas on how to make museums more accessible. Through the SIS scheme I managed to fully fund a project aimed at increasing the attractiveness of museums to children and their families, and to challenge the misconceptions that museums are not places where one can have fun. The project called "DressMeUp" is targeted at young children visiting the museum.

This project makes available a large number of costumes which will allow children who visit the cathedral museum to dress up as characters that can be seen in the museum paintings and who lived during the historical periods covered by the artefacts. The project targets the museum's existing educational programmes but also aims to attract hundreds of potential child visitors to the museum. The project has two deliverables: the costumes and a treasure hunt designed for young visitors and aimed at making their visit more fun and educational.

When the project was launched in August 2018, we were very surprised that the costumes were an absolute hit with adults (especially tourists). The way the costumes had been designed allowed them to be adjusted to fit various sizes. The planned positive feeling enhancing the visitor experience was being enjoyed by many adults. Adults having fun with relatives and friends often meant that they would want to share these experiences on social media, especially on Instagram. This we could see as visitors taking selfies while wearing these costumes were asking museum staff how to best tag the museum. This resulted in increased incoming links and referrals to the museum's own Facebook page and website.

The Mdina Cathedral Museum has until recently been a very traditional museum focusing only on the objects on display, offering minimal visitor engagement. The introduction of new museology is a big museum-wide culture change and a completely different approach. I wished to design a project aimed at making the museum more accessible to the visitor, attracting new audiences and making the existing ones more engaged and satisfied with their visit. In 2018 I applied for funding for a project called 'MuseumAccess' aimed at challenging the traditional role of museums, namely, to collect objects and materials of cultural, religious and historical importance, preserve them, research into them and present them to the public for the purpose of education and enjoyment. For museums to retain their relevance and become positive partners in

the development of our societies, they should use their unique resources and potentials to integrate more responsively to the dynamics of modern society and urban change (Silverman, 2006).

The project is made up of five separate but related actions all meant to make the museum more open and accessible to the public. By improving accessibility and taking a new approach to the visitor experience, the Mdina Cathedral Museum aims at putting into practice the latest trends in modern museum presentation – that of putting the visitor at the very centre of the museum experience. The following is a brief overview of the project actions that I have designed for the museum

Action 1: Autism Friendly Museum. The aim of this action is to create Malta's first Autism Friendly Museum. Increasing museum access is not only about making museums more wheelchair accessible. Ensuring that visitors with different forms of special needs feel welcome and catered for is essential to increase accessibility for all audiences. Over the last years we have seen a significant increase of people on the Autism spectrum (CDC, 2019) . These people, like those who suffer from some other form of disability, often stay back from visiting museums as they are afraid that such places would not be geared to meet their special needs (Braden, 2016). People with special needs often check beforehand whether a particular place is accessible. In today's connected world the normal place to check for such information would be the website of the museum. For this reason, I created a special section to provide information to people on the Autism spectrum and to their carers. In this part of the website, one can find information to help plan the visit, such as plans of the museum, highlighting both quiet zones and those areas which might be too loud and noisy. Downloadable planners including photographs of the different halls are available on the website for parents and carers to help them plan the visit. On the website

there is also information on facilities available at the museum such as noise cancelling headphones and a *safe room* where children can go if they are feeling over anxious or too stressed. This project was launched in the end of October 2019 after all museum staff members had received professional training in empathizing with and understanding people on the Autism spectrum and also on how to handle related situations that may arise within the museum. When researching museum accessibility for visitors with special needs, I found out that museums often focus a lot on the physical accessibility but often forget about digital accessibility. As more museum experiences become dependent on digital technology, assessing digital accessibility becomes a priority (Lisney et al., 2013). Some of the museum professionals I spoke to during informal interviews, about increasing museum accessibility to disabled visitors did not realize that audio guides for people with vision impairment needed to have different content from the general usage audio guides.

Action 2: Informal learning space in the basement: Similar to the strategy adopted for the *White Tower Project*, I strongly believe that museums should be very attractive to younger visitors. These are the future adult audiences, and can attract significant family audiences. Action 2 involved the setting up of a learning space in the Cathedral Museum's basement. This space would be used for activities by children who come to the museum, particularly visiting students engaged in existing learning programmes in symbolism and art literacy, organised by the University of Malta and the Ministry of Education (Gellel, 2018). The learning area has been designed to provide a very casual and informal space. Rather than using desks and chairs, which convey a classroom feeling, I used comfortable bean bags which could be easily moved around to create an informal setting. The learning area was equipped with laser projection, a PA system with cordless microphones, wireless connection broadcast from the teacher's laptop to

the projector and a networked media player for the looping of content when the area is used as a projection room for general museum visitors.

Action 3: Temporary Exhibitions zone. In an effort to open up the museum to more local artists, the museum is encouraging the latter to exhibit their works within the temporary exhibition and installations area set up in the vaults. Making available such an area for temporary exhibits ensures that the museum attracts creative works by local, contemporary artists. It will also be supporting the local arts scene through making available this temporary exhibition space by adding a much-needed space. Although no digital-tools were directly used in this action, the temporary exhibition area is heavily promoted via the Museum's social media and website.

Action 4: Interactive exhibits – Following the successful implementation of the interactive unit for the *#MeetDurer* project, the museum is looking at installing more similar interactive units in other areas of the museum to engage visitors whilst they are exploring the museum. Two interactive units will be introduced in another two halls. The first interactive unit will be placed in the Sala Grande Hall and will feature information about the 17th - 18th century Baroque Style paintings in this gallery, as well as the recently restored Medieval choir stalls on display in the room. The second interactive unit will be placed in the Marchese Hall and will feature information about the 14th - 16th century paintings as well as the famous polyptych of St Paul. This is the oldest altar painting in Malta, and was commissioned by the Cathedral Chapter to one of the most important art schools in Europe – that of Luis Borrassa of Cataluña in Spain (1360-1426). The central piece of the polyptych of St Paul, showing the enthronement of St Paul, is surrounded by other panels showing various episodes from the life of the Apostle of the

Gentiles. Through the interactive unit, visitors will be able to explore each of these panels and discover the story behind each one of them.

Action 5: Volunteers' Drive – This is a social media campaign to encourage members of the public to volunteer their time and effort in the museum as wardens, event helpers and ushers. This whole project will thus help the Mdina Cathedral Museum improve accessibility for people with Autism, improve children's learning experience offered within the museum, increase the collaboration and promotion of local artists, enhance visitor experience through the introduction of digital tools and attract members of the public to volunteer and be involved in the museum.

3.4 COST Actions

Museum development in Malta frequently follows what is happening in the sector in mainland Europe but often there is a significant time gap until the local scene picks up what is happening abroad. For my research to be truly relevant to the sector, I wanted to ensure that I could easily access international expertise, peer discussion and international museum practice. Although the web has made access to academic papers, journals and case studies more easily available than ever before, desk research in this aspect has its limitations. It is practically impossible to apply observational research without actually being present on site to observe the implemented technology. Limiting observational research to local heritage and museum sites would not give a complete and realistic picture, especially because the implementation of these new approaches to museology and digital tools is still limited locally. This meant that I needed to visit museums and heritage sites abroad. Self-funding this travel had its obvious limitations and this is why I started looking at EU funded programmes that would help me visit sites located abroad as well as network with museum professionals. COST provided me with the required platform to carry out this part of my research.

Founded in 1971 the European Cooperation in Science and Technology (COST) is the longest running European intergovernmental framework for networks in research and innovation (Buchanan, 2019). The main objective of COST is to support cooperation between researchers in multidisciplinary cooperation across different technology and science domains.

Following a business breakfast, in 2016, targeting the local industry stakeholders, organised by the local COST chair Dr Janet Briffa, it was explained how SMEs were being encouraged to join some of the active COST Actions. I have always believed in the power of networking, and COST was unlike any other EU funding platform I had come across. Following this I presentation, I

went through the lists of new and active COST Actions and selected one which was of interest to my multimedia work in the cultural heritage sector. Since then I have joined two different COST Actions and submitted my own action which is currently under review. As can be seen from the review below of the COST Actions I participated in, COST provided me with 1) a system which allowed me to visit a number of sites in Europe and Israel , through COST meetings, Scientific Missions and Training Schools and 2) access to networking with top professionals in the sector from all over Europe. Each participating country is allowed two members to join the management committee of the action. COST Actions offer a number of tools that allow members in the COST Action to meet, network and carry out their own investigations:

Meetings - Over the 3 year course of the action, management committee meetings and work group meetings were regularly held in different member countries so that the action members could meet and work on the action's and work group's agendas.

Short Term Scientific Missions (STSM) – These are short term exchange visits between researchers participating in a COST Action allowing them to visit an institution within another COST member country. They are aimed at encouraging collaboration between research institutions, and networking with an aim of sharing new research findings and techniques. The maximum duration of a STSM is 6 months.

Training Schools – These are intensive training sessions held on topics related to the action, for example, building reuse, data collection in heritage buildings or 3D scanning techniques. Young researchers from all over Europe can join such training schools which also offer a unique opportunity for networking.

TD1406 - Innovation in Intelligent Management of Heritage Buildings (i2MHB)

The first COST Action that I joined in 2017 was “TD1406 - Innovation in Intelligent Management of Heritage Buildings (i2MHB)” (COST, 2019). The action’s objective was the creation of a Pan-European network of experts, industry stakeholders and researchers aimed at creating a better and unified understanding of managing Heritage Buildings. This would be achieved through a global network of partners and a multidisciplinary approach together with the use of technology.

Participants of the COST Action were divided into five Working Groups (WG). Each WG would work on different aspects of the action. I was initially assigned to WG2, which was responsible for developing a framework of technologies and interoperability methodology and procedures that could improve Heritage Building (HB) rehabilitation and management. The action’s main objective was to develop a common framework bringing together multidisciplinary expertise and technology.

Throughout the whole COST project, I was very actively involved in all the meetings of the management core-group committee, as well as in Work Group meetings. For the duration of the COST Action I also participated in a number of training Schools as well as four Short Term Scientific Missions.

The three STSMs I participated in were in Israel, Cyprus and Germany. In Israel I was hosted by Dr. Rebeka Vital, Ph.D., Senior Lecturer at the Department of Interior–Building and Environment Design at Shenkar College of Engineering, Design and Art. During my visit I had the opportunity to discuss with Dr. Vital a number of projects relating to 3D scanning and photogrammetry which Shenkar College had carried out in Acre and Masada. Dr. Vital also helped me plan the historical site visits in Israel which covered Acre, Haifa, Masada, Cesarea

Maritima and Jerusalem. Given that these sites were spread all over Israel, I rented a car to be able to make my way to the various sites. At these sites I was able to see the projects carried out by Shenkar College as well as evaluate the visitor experience and any digital-tools in use. Being able to stay overnight in some of these cities, such as Acre, offered an even more complete perspective of these sites especially during off peak tourist times. A report of my Israel STSM can be found in the Appendix.

My second short term scientific mission was in Cyprus, where I was hosted by Dr. Marinos Ioannides from the Cyprus University of Technology, Department of Electrical Engineering, Computer Engineering and Informatics. Dr. Ioannides is also UNESCO Chair and EU ERA Chair on Digital Cultural Heritage. At the Cyprus University of Technology, Dr. Marinos gave me an overview of the important work being carried out under the H2020 project Virtual Multimodal Museum. This project focuses on technological developments fuelling a growth in Digital Cultural Heritage (DCH) and Virtual Museums (VM) in particular. During my stay at the Cyprus University of Technology Dr. Marinos showcased the digital work they have done on a unique Byzantine church, Panagia Asinou Church. An in-depth study and a historical timeline of the church including the alterations that were done over the ages were built using 3D technology (<https://apsida.cut.ac.cy/items/show/45036>). Together with other Masters and PhD students working on this project we had a very interesting discussion on what types of digital tools would be best suited to interpret this priceless historical site. Following my visit to the Cyprus University of Technology, I visited three historical sites around Cyprus, the Necropolis of the Tomb of the Kings in Paphos, the converted mosque of Selimiye Camii in Nicosia and the Church of Panagia d'Asinou in the Troodos Mountains. I have kept in touch with Dr Marinos who is also one of the cosignatories of the new COST project I submitted a few months ago.

My most intensive STSM was to Italy, specifically to Turin and Florence. This trip was hosted by Dr. Massimo Migliorini from SiTi – Istituto Superiore sui Sistemi Territoriali per l’Innovazione, now renamed LINKS (<https://linksfoundation.com/>). The main area of investigation at SiTi was Virtual Reality (VR) and Augmented Reality (AR) where I had the opportunity not only to learn about the innovative AR and VR projects that were being carried out at SiTi but also had the chance to try out the different equipment and software being used. This research institute is jointly owned by the Politecnico of Turin, and Dr. Migliorini put me in touch with one of their departments handling EU funded projects related to digital imagery of cultural heritage sites. Following the STSM mission I have kept in touch with Dr. Migliorini and managed to get the new LINKS institute and the Politecnico of Turin to work with the University of Malta on an Erasmus+ exchange as well as an H2020 project related to AR and VR. Following my visit to SiTi, I spent time at the Mole Antonelliana Museum of Cinema, Palazzo Madama, the Museo Egizio, The Royal Armoury of Turin and the Royal Palace including the chapel of the Holy Shroud. Later I travelled to Florence where I visited the Uffizi Gallery, the Duomo and Battisterio, The Galileo Museum and the Leonardo da Vinci museum.

My fourth and last STSM was to Berlin in Germany hosted by Dr. Dalik Sojref. My short visit in Berlin focused on two museums. The first was the *Topography of Terror* museum located on the site of a previous block of buildings used by the Nazi regime including the headquarters of the Gestapo, the Sicherheitspolizei and Einsatzgruppen. The second museum was the *Bode* on Berlin’s Museum Island (Museumsinsel), where I focused specifically on the numismatic collection. Reviews of these different sites can be found in the Appendix.

Apart from the sites identified above as part of the STSMs, I have always tried to make sure that when I travelled to attend workgroup or management committee meetings, I would try to visit at least one or two sites. During this COST I also attended two training schools. The first was organised by the Università della Sapienza, Department of Antiquity. It was during this training school that I had the unique opportunity to visit and review the VR experience within the Domus Aurea. Another training school was held at the historical site of Olimjie in Podčetrtek. During this training school the lectures focused on the topic of digital technologies in the valorization and protection of historical sites and cultural heritage. During this training school I gave a presentation on Case Studies regarding digital volunteers for cultural heritage.

The table below shows the different sites visited and researched over the last two and a half years. Participation in these events gave me a unique opportunity to discuss topics of interest with academics as well as industry stakeholders from different countries. Although attending such events was quite challenging since I had to travel so often, and COST does not cover the expenses completely, I had the opportunity to visit a number of museums and cultural heritage sites all over Europe. The experience helped me understand how different countries and their organizations are using digital tools to help in interpretation and in the creation of effective and interesting visitor experiences thus enabling me to put together a much wider picture of cultural heritage interpretation across Europe. There are significant differences between different countries regarding the quality of interpretation and the emphasis on visitor engagement.

Once the project got underway, I was asked to join Work Group five which was geared towards the dissemination of the project research findings to stakeholders and to the general public. My role within this group was the setting up and management of the project presence on social media, primarily Facebook. In one of the very first core management meetings, I strongly

supported the idea of setting up an eBook as one of the deliverables of the project. The idea behind this deliverable was to create an innovative publication to target the general public. The eBook was not meant to be a scientific publication but more of a general overview of the COST project itself. Apart from giving information about the general activities and deliverables of this project, the eBook would highlight the advantages of joining similar COST Actions by students, academics and SMEs. A Spanish multimedia company was selected to design the eBook but, more than two years into the project, very little was done and the company eventually gave up on the eBook. Not wishing to see the eBook deliverable being discarded, I volunteered to work on it myself and make sure that it would be ready by the end of the COST project.

When I took over the eBook, I realized that I would have to start from scratch as the designs which had been produced by the selected supplier did not follow the official COST branding and publication guidelines. This in a way proved to be an advantage since it allowed me to design the eBook in the way I thought would be most effective. The biggest challenge in designing the eBook was collecting information from different work groups and designing it in a way to make it attractive and easy to understand by the general public. The eBook had four main sections which covered the history of COST, the COST Action itself, the members of the different work groups and the deliverables of this COST Action. Since the eBook was aimed for the general public, I did not want it to be too academic or technical since I wanted everyone to understand what our action was about. I collected points from each working group and edited all the content. I also filmed and edited a number of video interviews to try to make the content more appealing to viewers of the eBook. It was very encouraging that Dr. Ronald de Bruin – director of the COST association and Dr. Estelle Emeriau, COST Science officer supervising this Action, both gave us Video interviews to be included in the eBook. Once all the material was

collected the eBook was designed following strict branding guidelines by COST and using Adobe InDesign. The content is published directly from the software to Adobe Cloud, a platform which offers an open, industry-standard solution to publishing and sharing media-rich content to the widest range of devices. Since the content runs online inside the browser, the person viewing it requires no further installation of software or applications, and the viewing features, such as pagination and zooming, are already integrated. The content was also prepared as a distributable file in the EPUB 3 format, which is the latest publication version supporting video, audio, and interactivity. These features, however, require compatible readers and an internet connection, since the videos are hosted online and streamed in the background from the YouTube platform. Once the eBook was completed, I was asked to register it in order to obtain a digital identifier. This was the first time I had registered such a digital object. Producing the eBook on time and to the requested specifications was a big challenge since I had, practically single handedly, to collect the material for it, design and publish it. The eBook is accessible online and stored within the Adobe repository and it can be found at this link:

<https://indd.adobe.com/view/ba92cf74-1104-4e9f-bdb8-b887a0554aea>

This COST Action ended in June 2019. It was a great opportunity to network, contribute to the topic, share research and follow closely what is happening in the latest digital tools for cultural heritage.

CA18110 - Underground Built Heritage as catalyzer for Community Valorization

Following the successful completion of COST Action TD1406, in the beginning of 2019, I joined a new COST Action focusing on Underground Built Heritage - CA18110 - Underground Built Heritage as catalyzer for Community Valorization (<http://underground4value.eu/>). This

COST Action aims to bring together an expert network of specialists aimed at promoting the sustainable conservation of the underground heritage as well as maximizing its potential for regeneration. Representatives of 27 countries participating in this action were split into five working groups. WG1 – Knowledge Base Development, WG2 – Conservation and Monitoring of Underground Space, WG3 - UH Strategies for Valorization and Reuse, WG4 - Planning Strategies and WG 5 - Dissemination.

The action's multi specialization approach allows the group to analyse the topic of underground heritage from various points of view including the use of digital-tools for interpretation and valorization giving a very wide perspective to the research approach.

In this COST Action I am specifically interested in finding out how different organizations and authorities around Europe are using digital-tools as part of the conservation, valorization and reuse strategies in underground built heritage, something that is very significant to Malta. Following my experience in dissemination and the eBook from the previous COST Action, Prof. Giuseppe Pace, from the Institute for Studies on the Mediterranean, National Research Council of Italy and the COST Action project chair, assigned me to WG5 working on the action's dissemination. This gives me the widest exposure to all the research and work being carried out in this COST Action.

Malta has a very important underground heritage covering thousands of years of our island's history. The hypogeum in Hal Saflieni, a unique underground structure, possibly the first to be hewn out of underground rock in the world, Catacombs, Valletta's tunnel systems, the Knights of Malta cisterns, the underground war rooms, the Victorian era train tunnels and the underground nuclear attack proof flour mills are but a few examples of the very rich underground heritage one can find in Malta. Any conservation or regeneration project needs to

take into consideration users and visitors, and underground heritage is no exception. My interest lies specifically in how to use the available digital-tools to improve the visitor experience as an integral part of the project. It would be very interesting to be able to apply research and conclusions from this action to real life projects in Malta's underground heritage.

The COST Action's first meeting for members was held at the University of Financial Studies in Ancona Italy in June 2019. Following the management meeting, I travelled to the municipality of Camerano to visit the underground city of Camera, where, beneath the old city centre hewn in the soft sandstone, is a huge complex of tunnels and structures dug from as far back as Roman times to the 1800s. During medieval times these tunnels were used as refuge from Moorish invasions, and were fashioned into a complete underground city reflecting the buildings above ground. During WWII the underground complex served as a huge shelter hosting more than three thousand people.



Photo Right: Stairs leading to the underground city of Camera,
Photo Right: One of the very long corridors / streets connecting the various chambers in the city.
Source: Taken by myself , Underground City of Camera, 2019

This situation is very similar to that of the underground system of tunnels, chambers and cisterns found in Valletta, which, although built during the times of the Knights, were enlarged

and modified during the Second World War to turn them into huge shelters during the Axis blitz on Malta. These tunnels and shelters are about three storeys below street level. They run along most of upper Strada Mercanti, Strada Santa Lucia, and parts of Strada San Paolo and Strada Santa Ursola in Valletta.

Heritage Malta, the government entity responsible for Malta's heritage sites, and also, for these tunnels, has recently temporarily opened the main cisterns to the public as part of the Public Service week in September 2019. Prior to this, in August 2019, I accompanied my tutor Prof. Vince Briffa from the Department of Digital Arts and Prof. Saviour Formosa from the Department of Criminology, on a 3D scanning exercise of a part of these tunnels and three huge cisterns beneath the pavement and parvis of St John's Square and beneath the Great Siege Square in front of the Law Courts. These different cutting-edge scanning technologies offer a different form of recreating immersive experiences, different tools which give different data, different approaches to interpretation and the reconstruction of a virtual space. When I was preparing my installation *Cathedra*, I used 360° photography to recreate the inside of the cathedral. This research has exposed me to other different digital tools such as various 3D laser scanning techniques as well as 360° videography used in VR experiences. Knowing the available tools to use allows the UX designer to select the most appropriate ones for the given task. It also illustrates how quickly technology changes. Thus, whilst 360° photography was considered cutting edge a few years ago, it is now being replaced by other forms of virtual tours.



Photo Left: showing temporary entrance to the underground cisterns under St. John's Square. Photo Right: members of the public putting on protective wear before descending into the tunnels.

Source: Heritage Malta, Facebook page.



View of one of the cisterns.

A staircase has been built to allow visitors to enter directly into the cisterns without having to pass through the maze of tunnels leading to them.

Source: Times of Malta.

“Using Digital-tools to create visitor centred experiences in Constructivist museums”

Based on the network of contacts I built over the last four years through these two COST Actions, Scientific Missions and training schools, I decided to form my own network to back a new COST Action. In July 2019 I submitted a new COST proposal entitled; “Using Digital-tools to create visitor centred experiences in Constructivist museums”. This COST Action was directly inspired by the ongoing research carried out for my Masters degree.

The main focus of this COST Action is to bring a varied group of experts from academia and industry to explore and discuss ways how digital-tools can improve visitor learning through more effective interpretation within museums. The team will explore how the divide between the traditional curatorial aspect and what are considered to be completely separate ICT tools is sometimes leading to ineffective or very slow adaptation of the digital revolution. The team of experts will explore how a multidisciplinary approach in cultural heritage interpretation is the solution to make better use of digital tools within the sector.

The action will specifically look at museum visits as a form of learning. Education and learning are one of the most important functions of Museums (Vital, 2017). Digital-tools can be the key to bring back fun and accessibility to museum learning thus changing visitor demographic realities. This COST Action aims to bring together the experts from different fields to discuss best practices in the interpretation and promotion of cultural heritage, with the main aim of making museums and cultural heritage sites more appealing and accessible to the general public. This networking effort will result in knowledge sharing, leading to the creation of engaging, value-added visitor experiences based on innovation, changing trends in museology, state-of-the-art practices, research, and technology.

The application was submitted in July 2019 and will pass through an evaluation stage, the results of which will be published in January 2020. Being a competitive call, there is a chance that the application would not be chosen and would have to be resubmitted following future calls. Even if it is not successful at this stage, the application process has given me the chance to discuss my ideas and research about the effective use of digital-tools with a number of co-proposers, who only accepted to back my idea, on behalf of their organizations, after reading, discussing and giving me feedback on my proposal. The proposal was backed by 23 different proposers, from 14 different COST country institutions, including Universities, research institutes and industry. A full list of proposers and their organizations is included in the appendix to this research. 93% of the proposers hold a doctoral degree in their area of specialization, and I have worked with most of them in previous COST Actions. I wanted to ensure that the idea of the multidisciplinary aspect of museum interpretation is reflected in the team of experts forming the core group of proposers. Their areas of specialization are grouped as follows:

21.7% Computer and Information Sciences

17.4% Arts

13.0% Economics and business

13.0% Electrical Engineering, Electronic Engineering, Information Engineering

8.7% Chemical Sciences

25.9% Other

3.5 Site Visits

Over the last three years I have tried to visit as many historical sites and museums, both locally and abroad, as was possible in order to carry out field work as one of the keystones of my methodology. The aim of these site visits was to observe how such institutions were tackling the visitor experience, particularly through the use of digital tools. The following schedule shows the different museums, educational organizations and historical sites visited over the last three years.

2017

Country	Type	Name
Israel	Historical Site	Acre
Israel	Historical Site	Masada
Israel	Historical Site	Western Wall
Israel	Historical Site	Cesarea Maritima
United Kingdom	Museum	Museum of London
United Kingdom	Museum	Transport Museum
Italy	Museum	Vatican Museum
Malta	Museum	Fortifications Museum

2018

Country	Type	Name
Italy	Museum	Academia Gallery
Italy	Historical site	Florence, Duomo Cathedral and Battisterio

Italy	Museum	Leonardo da Vinci Museum
Italy	Museum	Florence, Museo Del Opera
Italy	Museum	Pitti Palace
Italy	Museum	Florence Uffizi
Italy	Museum	Galileo Museum
Italy	Museum	Mole Antonneliana, Turin
Italy	Museum	Museo del Risparmio
Italy	Museum	Royal Palace and Armoury
Italy	Museum	Turin Cathedral and Shroud
Italy	Museum	Museo Egizio
Italy	Historical Site	Domus Aurea
Italy	Historical Site	Colosseum
Italy	Historical Site	Camerano Ancona
Belgium	Museum	Trainworld
United Kingdom	Historical Site	Roman Baths – Bath
United Kingdom	Museum	SS Great Britain
United Kingdom	Museum	Wells Cathedral / Bishop’s Palace
Malta	Museum	Wignacourt Museum
Malta	Museum	Esplora
Malta	Historical Site	St John’s Cathedral

Country	Type	Name
Germany	Museum	Bode Museum
Germany	Museum	Topography of Terror
Cyprus	Historical Site	Church of Panagia d'Asinou
Cyprus	Historical Site	Selimye Cami
Cyprus	Historical Site	Tomb of the Kings
United Kingdom	Museum	Ashmolean Museum
United Kingdom	Museum	British Library
United Kingdom	Museum	British Museum
United Kingdom	Museum	Victoria and Albert Museum
United Kingdom	Museum	Science Museum
Spain	Historical Site	Seville Cathedral
Spain	Historical Site	Cordoba Cathedral
Spain	Historical Site	Seville Bullring
Italy	Museum	Castel Sant'Angelo
Poland	Museum	Auschwitz and Birkenau
Poland	Museum	Schindler's Factory
Poland	Historical site	Wieliczka Salt Mine
Malta	Museum	MUZA
Malta	Museum	Fort St Angelo

The selected sites give a good cross section of different types of museums and cultural heritage sites. The choice of country / town was often influenced by the destination of COST

Action meetings, short term scientific missions, training schools and personal travel. The museums / cultural heritage sites I chose to visit and review were normally picked from among the top rated sites recommended by Trip Advisor and Booking.com. The fact that site reviews were crowdsourced through the contributions of thousands of travelers submitting their own reviews added a level of independent and reliable ratings, making the two sites my preferred source of referrals. The success of both Trip Advisor and Booking.com depends on the pooling of thousands of review ratings by their users. I did not use travel blogs since it is often not possible to clearly identify whether reviews are paid or not. Once the different sites were chosen, my on-site observational research was a postmodernist approach with a mix of *complete observer* and *complete participant*.

Just like a potential tourist / visitor, prior to visiting the site, I would carry out some basic research online. I would look for the site's web presence and gather basic information about the museum or cultural heritage site I would be visiting. I tried not to let myself be influenced by the quality of the website itself, though this undoubtedly created a first impression. Websites for different sites varied immensely; some used the latest tools such as online databases of artefacts, online exhibits and 360° tours while others were very poor in their design and content. Once at the site I would, just like a normal visitor, spend some time exploring the venue, using my own experience to build an opinion of the site. I would observe staff friendliness and appearance, directional signage within the museum, didactic boards and labelling, the quality of the display and interpretation material, and would try gauging how much I was enjoying the visit. I would also note ancillary services such as coffee and souvenir shops, seating, availability of toilets, Wi-Fi within the museum, cleanliness and overall comfort.

I would specifically look out for the use of digital tools such as touch screens, audio guides, projection or directional audio. Wherever available, I would rent an audio guide to use within the museum. Doing this, by selecting points of interest, I looked for the way the audio guide worked, whether sensor driven, sequential or user driven. I looked at the way the narrative in the content was retold, whether it was just describing the artefact or putting it into context possibly with some interesting storytelling, use of sound effects and music, quality of English audio and effectiveness of the description of the items being described. Where interactive screens were available, I would make sure to try them out and look for their ease of use, navigation, quality of content and visualization, and see whether any element of gamification was included. Whilst these digital-tools were tested both through observing users as well as through my own use and interaction whilst visiting the museum, I tried my best not to let them overly influence the whole visit experience. I tried to look at the quality of the visit; how much the museum managed to grab my attention, how effective the interpretation was and, ultimately, how much I enjoyed myself were dependent on the whole set of elements that make up the museum's visitor experience.

Once I get a good feel of the museum, I would then choose a hall or gallery, find a secluded corner where I could look at visitors and observe them as they go about their visit in the museum. Very often I would try to find spots close to some digital-tools such as touch screens, but these are still not too common. Moreover, I wanted to look at the overall experience from the other visitor's point of view. Things I was looking out for were: whether they were using audio guides next to designated information points, and whether they stopped to look further at artefacts once they heard the audio guide narration for that point. I tried to see whether visitors who had an audio guide reacted differently from those who did not. I looked at children visiting

the museum, trying to see if the museum managed to capture their attention as well, and how this was affecting the whole dynamics of the family visit. I looked at people's faces, at their expressions and reactions. In a way I imagined myself being in a Sims game trying to gauge the entertainment level and mood of visitors (Consalvo, 2003). All this observation was geared towards trying to put together all that the museum offered in terms of visitor experience and trying to understand how the visitors were reacting to it. The Appendix contains a sample of reviews, reports and case studies for some of the sites visited.

4. Final Project

4.1 Project Background and Outline

The final project demonstrates how the research carried out in my studies was applied to the creation of an interactive exhibit aimed at improving interpretation within the Albrecht Dürer Hall at the Mdina Cathedral Museum. It highlights the methodology, the process, the difficulties and challenges faced when implementing digital interpretation tools within a museum.

The final project was developed over a period of 9 months from the initial conception stage to the production and implementation phase. Stanford University's methodology of Design Thinking (Plattner, Meinel, & Leifer, 2012) was applied at all stages of the project. As explained in the literature review (section 2.7), this is a tried and tested methodology which has already been used in various museum visitor engagement projects worldwide.

'#MeetDürer' is an interactive multimedia experience aimed at illustrating how digital tools can be used to enhance museum exhibits in order to make museum visits more interesting and engaging. The final project is a full working prototype which was displayed as part of the Degree Exhibition of the Master for Fine Arts (MFA) in Digital Arts exhibition, "One | Six", held at Spazju Kreattiv in Valletta, in June 2019.

The project has three components: Digital signage content aimed at getting visitors interested in visiting the museum exhibit; a multitouch interactive unit aimed at providing information about the artist and the museum's collection to visitors in order to help them understand better what they are looking at; and finally, a photo opportunity to illustrate the concept of user generated content as an important marketing tool on social media and on the web.

This project's outputs were also installed within the Albrecht Dürer hall at the Mdina Cathedral Museum. The collection of Dürer prints in Mdina is one of the largest and most important outside of Germany (Vella, 2017). The prints form part of the original collection bequeathed by Count Saverio Marchese to the Mdina Metropolitan Chapter and was the first collection ever passed on to a public institution, which was to serve as the basis for the setting up of the Cathedral museum (Azzopardi, 2018). Initial research showed that, notwithstanding the recent redesign of this hall, the time spent by visitors in this hall was extremely short, clearly indicating that visitors were not appreciating or understanding the value of the prints on display. This project is meant to serve as a catalyst in the efforts to transform this traditional museum into a more visitor-centred one.

The complete solution needed to be delivered within a relatively low budget, both in terms of hardware and software. This was the first digital interactive unit being installed in the museum, and its success would significantly impact the museum's acceptance of other digital tools for visitor engagement.

The '#MeetDürer' project uses a multidisciplinary design approach focusing heavily on audience development, visitor engagement and museum learning. It was also designed for a specific museum, and hence the proposed design needed to meet the special requirements of this particular museum, highlighting the important message that there is no one size fits all solution, although the research and implementation process can be easily transposed to any museum or interpretation centre setup, irrespective of both technology used and venue.

The Mdina Cathedral Museum is located next door to the Mdina Cathedral at the very centre of the old capital city of Malta. The building housing the museum was originally constructed in 1733 by Bishop Fra Paolo Alpheran de Bussan as Malta's first purpose build

seminary. The building was converted into a museum 60 years ago and the collection of artefacts housed in the sacristies of the Mdina Cathedral was moved to this building. More information about the museum's history can be found in the Appendix App 4.11. The nature and history of the Mdina Cathedral Museum makes it unique since traditional cathedral museums are normally annexes to cathedrals where valuables, mostly consisting of ecclesiastical valuables and vestments, are put on display. The collections within the Mdina Cathedral Museum are almost all bequeaths from a wide variety of donors including clerics, noblemen, Maltese families, artists and benefactors. The nature of the artefacts on display is a glimpse into the Maltese cultural heritage over the ages. The exhibits are a rich mix of sacred and profane artefacts. Over the last few years, the museum has undergone an extensive refurbishment project which has seen most of its galleries and halls refurbished and redesigned.

Apart from the flurry of activity in the building's restoration over the last two decades, a more silent but even more important development has been steadily taking place within the Cathedral Museum. Since the very beginning, the museum's aim was the preservation and conservation of the bequeathed works of art. Over the last few years and particularly under the direction of the museum's new curator Mons Dr. Edgar Vella, the museum is slowly but gradually moving away from the traditional cabinet style showcase museum into a more engaging visitor centred one. This is not an easy change as it requires a substantial change in the *forma mentis* of the Metropolitan Chapter, who for many years felt that the public should be grateful to the museum for conserving and preserving the collections and that it was the public's privilege to be allowed a glimpse of these treasures. Moreover, the museum still falls under the umbrella of the Mdina Metropolitan Chapter, which is significantly traditional and conservative in the way it looks at how the Museum should function. Yet the positive effects of contemporary

approaches to museology are gradually bearing fruit. As the visitor is being placed at the very centre of the museum's visit, their needs are being given much more importance. This has resulted in improved facilities for visitors, a more branded approach and an understanding that museum audiences are complex and varied. There has been an ongoing shift whereby the visitor experience is now being designed around the visitor and not simply around the museum.

As the museum looks at improving visitor engagement and participation, it is now looking at engaging new modern digital tools to make this visitor experience even more effective. The museum has successfully obtained funds to introduce interactive digital tools in a number of the museum halls. Audio guides covering the whole museum and cathedral visit will be introduced by the end of 2020 and multimedia screens and projections will be used to narrate stories related to the artefacts and collections on display.

An overview of the Albrecht Dürer Collection shows the very interesting origins and provenance of this collection which formed part of the original core collection bequeathed by Count Saverio Marchese, used to setup the Mdina Cathedral Museum. This interesting history can be found in the Appendix APP 4.12. A study of the museum's audiences shows that the museum has 3 main audience groupings; group tourists – the vast majority of whom are tourists who often visit the cathedral but have very little time for the museum, foreign independent tourists who make up the bulk of the museum visitors and Maltese independent visitors which include families and students. A detailed breakdown of the museum's audiences can be found in APP 4.3. The Dürer hall.

The Dürer hall, found on the first floor of the museum, is housed in what was once one of the seminary dormitories. The displayed original Dürer engravings make this space one of the most important halls within the museum. The Albrecht Dürer collection is made up of two sets

of prints. The first is the complete set of woodcut prints ‘The Life of the Virgin’ showing various anecdotal scenes from the life of our Lady, mother of our Lord Jesus Christ. Albrecht Dürer produced 19 different scenes in woodcut, between 1500 and 1504 (Kurth, 1963). The second is the complete collection of copper plate prints of ‘The Small Passion’- a collection of 36 woodcuts related to the story of the passion of Christ, as well as stories from the Old Testament linked to the sacrifice of Christ the Saviour. There are also a few miscellaneous engravings.

All the prints are original and are signed with the typical AD signature. On display are also a number of masterpieces such as *St. Jerome in His Cell*, *The Virgin and Child with the Monkey* and *St. Christopher* (Museum, 2017). Of particular interest are four very interesting engravings which are not by Albrecht Dürer but are copies of his works produced by fraudist Marcantonio Raimondi who made illegal copies for resale. Dürer sued Raimondi as soon as he found out about this. Dürer won the case and the court ordered Raimondi to remove the fake AD signatures from the etchings. Out of these four Raimondi prints on display two include the fake AD signatures while the other two do not.

In April 2018, the Albrecht Dürer hall was completely renovated under the guidance and advice of eminent scholar Martin Royalton-Kisch. Mr. Kisch has for many years worked as a curator at the British Museum in London within the department of Prints and Drawings. Through the financial assistance offered by the Federal Government of Germany, the prints were reframed using special museum glass to preserve them ensuring protection against harmful light.

4.2 Learning Outcomes and Methodology Used in Designing “Meet Dürer”

In the end of 2017, the Dürer Hall was undergoing a complete redesign. The museum, aware that digital tools could be used to improve visitor experiences, issued a call for quotations for the development of a touch screen interpretation unit. The museum considered this as an ICT project, and, as a result, the focus was on the ICT hardware with little consideration or focus on the desired content, learning outcome/s and audiences. When one prospective supplier asked where he could go to interview Albrecht Dürer as content for the kiosk, the museum realized that installing digital tools in its halls was much more than issuing a quote for ICT hardware. I met the museum administration and curator and discussed my approach and methodology. I offered to carry out this project and at the same time use it as my thesis project. This was accepted and I could start working on the #MEETDÜRER project.

The #MEETDÜRER project was designed on two basic principles: it would be visitor-centred and team based. *Design Thinking* methodology was applied to cover the development of the whole project.

- i. **Visitor-centred:** I wanted to put the visitor at the very centre of the visit experience. This places the project at the forefront of the big shift happening in museums worldwide, that is a shift from objects-centred museums to a more visitor-centred approach (Mccall & Gray, 2014). Through this project, I wanted to create an implementation blueprint which could be used for any other museum collection even possibly using other digital tools.
- ii. **Team-based approach:** through this project I wished to show that the best approach was to have a multidisciplinary approach, involving different team members with

different backgrounds, competencies, specialisation, experience and knowledge. A varied team setup would offer different perspectives and allow professionals to work together as one team rather than just be led by one department. Digital tools become effective tools aimed at improving the visitor experience and not an end in themselves.

Why the name #MEETDÜRER? As explained above, the project is visitor-centred. It is an intimate experience of discovery by the visitor of who this master artist was, where he came from, what period he lived in, what art he specialised in, and what was the relationship between the artist and the Mdina Cathedral museum. The visitor is encouraged to meet and get to know Albrecht Dürer.

Methodology - I decided to use the Design Thinking methodology, developed by D-School of Stanford University (<https://dschool.stanford.edu/>), because this methodology is a proven approach ideal for innovative problem solving. This methodology has been reviewed in section 2.7 of the Literature Review. The project design and development followed the methodology's five phases which are ; understanding user needs through empathy, defining the problem, identifying solutions, prototyping and testing.

A 'project team' made up of museum staff, the museum curator, the chapter administrator as well as multimedia designers and developers met together to discuss the various aspects of the project. It was very important that the whole discussion centred on the visitor experience within the Mdina cathedral museum, specifically within the Albrecht Dürer Hall. The multidisciplinary

approach, especially the inclusion of all levels of staff, was a first for the museum which normally took a more top-down curatorial driven approach in decision-making.

Design Thinking stages in practice

1. Empathy: The project team met initially to discuss why they thought that visitors spent a very short time within the Dürer Hall at the museum. Feedback from the museum staff was especially important to understand some of the main misconceptions by visitors. Some of the shocking comments included that some visitors thought that the Dürer prints were actually newspaper cuttings or pen drawings. The participants agreed that the absolute majority of visitors lack even a basic knowledge about what they see in this hall. The only exception was the majority of German tourists who knew who Albrecht Dürer was and could thus appreciate the collection.

2. Define: It was agreed that the principal reasons for such short visit times in the Dürer Hall, even after the refurbishment, were all related to lack of knowledge and appreciation of the subject matter. Visitors entering the hall did not know;

- who Albrecht Dürer was,
- what art he specialised in
- what were the techniques used to create the prints on display and the differences between woodcut and copperplate engraving
- the thematic and meaning of the prints, and the symbolism incorporated in them
- the value and origins of the museum collection itself

It was very important to identify the above five points because they set out what the whole project needed to tackle. If the museum could effectively communicate information on these

points, then visitors could understand better what they were looking at and, as a result, spend more time in the hall. These points thus became the basis for the learning outcomes.

3. Ideate: Once the project team had a good understanding of the Museum's audience as well as the specific issues and challenges faced by the Dürer Hall, the project team sat down together to identify possible solutions as to how these challenges could be tackled whilst keeping the visitor at the very centre of the solution. The museum management put some constraints in terms of technology and budget but the project team was given a free hand in terms of content delivery and creativity. It was decided that the three main deliverables of #MEETDÜRER would be; a cinematic trailer, an interactive touchscreen information system and a Photo Opportunity to create user generated content. The cinematic trailer, the interactive touch infokiosk unit and the Dürer photo shoot were all targeted at familiarising the visitor, actual or potential, to learn about Dürer and the collection. The ideas for each of the three deliverables are discussed in the next section.

4. Prototyping

Prototyping is an excellent way of testing innovative ideas in order to avoid costly mistakes when finalising the product. Prototyping involves creating an inexpensive, scaled down version of the product to try to identify any flaws or design issues that could affect the final product. For the #MEETDÜRER project we mainly used paper prototyping to understand how users of the interactive touch unit, would interact with the product. Easy to understand and accessible navigation ensured that the final touch screen unit could be used by anyone including children.

Prototyping allowed us to experiment with menu placements, screen content navigation and testing user response before going into the design and coding phase. This avoided very costly iteration in the final product.

5. Testing

Testing and prototyping moved hand in hand. Once a prototype was created, users from the project group would test it, and following observation of their reactions and discussion of their feedback, changes would be implemented where necessary to the prototype and subsequently tested again. Given the nature of the paper-based prototypes it was relatively easy to carry out these changes. This iterative process was repeated until we were satisfied that the prototype would meet the user's needs and expectations in an effective way. Given the varied composition of the team, we felt that this gave a representative feedback of visitors in general life.

At the end of the project, the participating members, especially the museum staff members, felt very satisfied that they could contribute creatively towards museum exhibit development and the improvement of visitor engagement within their museum. This exercise was better than any lecture or course aimed at trying to identify and explain the system requirements, it helped put the visitor at the centre of the museum experience. I can safely say that the whole process was also a strong team building activity where everyone felt involved and appreciated.

4.3 Final Project Deliverables

#MEETDÜRER project has 3 principal deliverables; the cinematic trailer, the interactive information unit and the user generated content. These three deliverables were identified by the

project team in the ideate phase of the project, although the chosen technology of the interactive touch screen system came from the management.

Visitors access these three deliverables before, during and after their visit to the museum, reflecting the new approaches to visitor experiences which are not limited to the actual physical visit within the museum itself.

4.3.1 The Cinematic trailer

Trailers are meant to act as teasers to the main movie, creating a sense of anticipation and capturing the viewers' attention, thus encouraging them to proceed to view the full movie or show. The cinematic trailer is meant to be viewed by the visitor before visiting the collection itself. Two different versions have been produced. A 30 second version is available for the web and social media including: the museum's website, the museum's FaceBook and Instagram pages, the museum's Google business page, the museum's dedicated YouTube channel and TripAdvisor which are the museum's primary sources of online referrals. A longer version of this trailer has been produced for the digital signage screens within the museum.

Given that foreign tourists make up the largest audience group, the trailer would provide interesting marketing content that will help them decide whether or not to include a visit to the museum when visiting Mdina. Over the last decade we have seen the rise of independent travel replacing almost completely the travel agency. The web gives tourists direct accessibility to all the information needed to plan and book every aspect of their holiday. Visitors traveling on work or holiday to a foreign country look up information online before their trip in order to help them maximize the value of their visit. Visitors tend to give a lot of value to recommended sites,

hence the huge influential value of such sites as Trip Advisor and Bookings.com. Sites which rank high on search engine results, and travel sites for that destination tend to be much more trusted and visited than other sites which do not feature. Creating multimedia content such as the cinematic trailer will ensure that the available content is much more interesting for visitors. Interesting content is in turn shared much more by visitors together with other sites offering information about places to visit in Mdina.

Local visitors also use social media to know what is happening, special events, festivals, open days and temporary exhibitions. Analysis of the museum's online presence shows that whilst sites like the Museum website, Trip Advisor and Google business appeal mostly to foreign visitors, the Facebook community is made up primarily of locals.

The cinematic trailer had to be interesting to watch in order to grab the users' attention. It also needed to give an overview of what to expect in the gallery itself, in a way which was compelling but not too obvious. In order to do this, I opted to recreate a short shoot which reflected the #MEETDÜRER concept. By having actors dressed up in 16th century costumes in a period themed diorama of an engraver's workshop, I wanted to create a feeling of 'meeting' Dürer in the short duration of the trailer. This immediately created a challenge, that of finding actors and location for the shoot. I needed a Dürer look alike as well as other props and accessories which would not trivialize the trailer.

During the discussion of these requirements with the rest of the project team, everyone was eager to contribute ideas and suggestions on how to make this trailer a reality. It turned out that three of the museum reception staff were members of a local historical reenactment group – the “Compagnia San Michele”. These members would be able to dressup and perform as actors in

the trailer, using their historically accurate costumes as well as props related to printing and utensils found in the artist's workshop.

An authentic Dürer costume was needed for the shoot. This was ordered from an Italian company, Medieval Design <http://www.medievaldesign.com/>, specializing in period costumes. The style of the costume had to replicate that worn by Dürer as displayed in one of his portrait paintings currently found at Del Prado.



Figure 4.1a - Left: Dürer's self-portrait at 26 Source: Prado Museum, Madrid

Figure 4.1b - Right: Photo of actor in the Dürer costume

Source: Taken by myself.

Filming of the workshop was carried out in the museum vaults. Though admittedly looking very different from how the surviving workshop in Albrecht Dürer's house in Nurnberg looks, the setting created a connection between the medieval master's work and the medieval seminary

building, housing the collection of Dürer Prints. The museum loaned some 16th century desks from a private collection and provided authentic woodcut and engraving tools. Museum staff, under the direction of the curator, set up the diorama and ensured that the setting was as authentic and historically accurate as possible.

In the short trailer viewers can meet Dürer sketching in his workshop, with his assistants helping in the production of prints. At one point a nobleman enters the workshop to meet Dürer and discuss the purchase of one of his prints. The plot needed to be super simple since there would be no narration or speech but only background noise effects. I wanted to ensure that the message was easily understood. The trailer's main focus was on the strong resemblance between Albrecht Dürer and the actor.



Figure 4.2 - Photos from the video shoot carried out in the museum's vaults.

Source: Taken by myself.

The choice of music was very important as I wanted it to impress the visitor, creating and reflecting intense feeling that would be associated with meeting such a great master as Albrecht Dürer.

After experimenting with all types of music styles, I settled for “Cry”, a track by Norwegian composer and multi-instrumentalist - Thomas Bergersen. It provided the necessary dramatic music which would be used for the fast sequence editing and setting of the overall tone of the trailer. All these elements are intended to make the visitor curious and want to visit the museum to meet Dürer. The trailer is not meant to be a documentary. I was aware of music copyright restrictions which would create problems with online distribution of the trailer, but was ready to go ahead with its use for two reasons. First of all, this would be a proof of concept rather than a real product. Secondly, the 3 minute trailer would not be used for online distribution.

Editing the video was quite a challenge as I wanted every screen shot to match every beat of the soundtrack. At one point of the video I used a very fast sequence of close ups from Dürer prints. The idea was to give a taster of what Dürer’s print work looked like. Yet the fast edit matching the music meant that viewers could see the prints without actually seeing them. Even though we had hours of filming, filling in footage for the 3-minute trailer was not easy as I wanted each shot to say something specific.

The production of the 3 minute cinematic trailer was quite challenging to carry out with the limited resources that I had access to. Even though I directed and produced the trailer, it would not have been possible without the involvement of all the members of the project team. The cinematic trailer more than any other part of the project was a clear example of the great benefits of team work. The multidisciplinary approach and involvement of a varied spectrum of stakeholders has huge benefits to museum interpretation projects. Not only did members contribute ideas, suggestions, skills and resources, but the whole process instilled a strong sense of ownership of the project itself. It was very satisfying that on the night of the launch of the One | Six exhibition all the project members attended to see the final project towards which they

themselves had contributed to make a reality. Copies of the 3 minute and 30 second trailer can be found in the USB attached to the Appendix.

4.3.2 The touch interactive unit

The interactive touch screen unit, meant to be strategically placed in the Dürer hall, was to act as the principle interpretation tool for the priceless collection. This unit had to meet four principal objectives which included;

- i. meet the learning outcomes identified for visitors visiting the Dürer hall,
- ii. be easy to use by any visitor,
- iii. be aesthetically pleasing and fit in with the overall hall design, and
- iv. complement rather than distract the visitor's experience.

These four principal objectives were the subject of much discussion, prototyping and idea testing within the project group.

Objective 1. Meeting the Learning Outcomes - The content presented on the interactive touch unit was designed to meet the five learning outcome objectives identified earlier:

- i. Who was Albrecht Dürer? – an overview of who the artist was, where he was born and lived, links he had with powerful rulers and patrons of his time and his artistic capabilities. This was delivered via a short, one minute video which used captions carefully timed with the footage, so that visitors could still understand what was being shown without having to wear headphones or disrupting others.
- ii. The engraving techniques – an overview of woodcut and copperplate engraving techniques used for the prints in the collection. A short video clip gave enough information for the user to understand the general process as well as the differences between the techniques.

- iii. The collection – Interesting museum visits and engaging storytelling go hand in hand, and the Dürer collection has one very interesting story to tell. This was narrated via a video clip explaining the provenance of the collection and how it eventually ended up at the Mdina Cathedral Museum.
- iv. Understanding Symbolism - To be able to understand and appreciate Dürer prints one should also be aware of the symbolism embedded in his art. This section picks up 4 particular prints and allows the user to discover the symbols used and their meanings. This section targets those visitors who want to delve a bit deeper into the subject, hopefully encouraging them to research further the topic once they leave the museum.
- v. Quiz - This is a short multiple choice question quiz, which the user can choose to answer once s/he has discovered the previous 4 sections aimed at testing the user's acquired knowledge and reinforce some of the learning outcomes.

Coding of the content on display was done in Flash and Action script, together with Adobe Premiere for the video clips.

Objective 2. Ease of use – Prototyping was extensively used to refine the navigation system proposed for the interactive touch unit. We wanted to ensure that users could easily navigate between the different sections of the content presented, without feeling lost or confused. Prototyping was also very useful to ensure that any user, including children and people in wheelchairs, could easily reach and use the navigation menu. For this reason, the navigation menu is available at the bottom part of the screen thus making it accessible to all users. It 'floats' on top

of the content being displayed so that it is continually available irrespective of the section the user is viewing. There is only one main menu, made of quick links to any of the five main sections. The 'Understanding Symbolism' section is the only part which uses a secondary menu to allow the user to move from one print to the other. Ease of use was given great importance because I was aware that for some users this might be new technology. I wanted users to feel at ease when using the touch screen. A navigation system, which was easy to understand and easy to use, would win the user's trust and confidence. The system was designed keeping in mind that users would be using their fingers to touch the screen and not a mouse. This consideration was incorporated into the overall design with large and separate clickable areas that did not conflict when users clicked on the screen.

Objective 3. Aesthetically pleasant and fitting design - The Albrecht Dürer Hall had just been refurbished, with a bold eye catching colour scheme aimed at placing the focus on the newly reframed collection prints. The touch screen unit was not only to be chosen for its functionality but it also needed to respect the aesthetics and style of the newly designed hall. A 42 inch multitouch landscape unit was chosen. The size of the screen made the display of content extremely easy to read by any user. The screen size offered ample space for both the content and the navigation menu to be displayed at the same time. With a 42 inch screen, the unit itself was quite large, so I chose a white colour finish for the unit which not only complemented the colour scheme of the room, but also put the emphasis on the LED screen rather than on the metal frame of the unit.

The hardware specifications of the unit were chosen after we knew exactly what kind of content would be played on the unit. This avoided potential low performance if the hardware was not powerful enough for the content or the unnecessary purchase of high specification hardware to make sure that whatever is displayed on the unit would work. As can be seen from the above process, the choice of hardware was definitely a secondary task and was only decided on once I had a complete picture of the project. In reality this is often done the other way round, with the choice of hardware coming first and the content and usage second. One final quality which we took into consideration with regard to the hardware was that it was structurally safe for users of all ages to use. The heavy metal base ensures that the unit does not topple over on visitors who may pull or push on the it .

Objective 4 - Complementing the visitor experience. The touch unit is meant to appeal to practically any user visiting the Dürer hall. The design and content of the unit takes into consideration the fact that visitors do not spend a very long time in the hall. The unit is not meant to answer every single question about Albrecht Dürer, his works and the museum collection, but should be enough to help the visitor understand and appreciate the prints on display.

4.3.3 Dürer Photo opportunity

Over the last decade we have seen two important developments which have had a significant impact on photography and the way photos are distributed and shared.

The first of these developments is the widespread availability of compact, lightweight and powerful smartphones equipped with very good quality built-in high-resolution digital cameras. This technological development has meant that now everyone had access to instant photography and photography was no longer the restricted territory of professionals. One of the biggest advantages of mobile phone photography is that the camera is always handy wherever the user is. Unlike professional DSLRs, a mobile phone is light in weight and fits in a pocket or small bag. Mobile photographers are constantly on the lookout for a photo opportunity, whether a selfie with some interesting background, a landmark, a fun moment with friends, happening news, or some mouthwatering food. To counteract the limitations of mobile photography, a multitude of applications exist to allow the user to turn an otherwise dull photo into a stunning image. Teeth become whiter; wrinkles disappear making middle aged people look like twenty year olds. These apps, which normally cost close to nothing, allow the user to creatively enhance, modify and improve the image on the fly directly through the mobile. Once the image is edited it is ready to be shared on social media, again directly through the mobile phone.

The other important development has been that technology allows the photographer to get instant gratification for his or her work. The ability to share photos on social media platforms, such as Instagram and Facebook, gives mobile phone photography a special appeal. Years ago, before the advent of social media, sharing and publishing a photo was very difficult, and it would normally remain on the user's album or hard-disk. Internet sharing of photos gives the user a great incentive to snap more photos especially when feedback from a wide audience is encouragingly positive. Sharing photos via the mobile phone is completely hassle free, no downloading onto the desktop to edit and store. Internet sharing gives immediate gratification and within seconds of snapping a photo it can be seen by thousands allowing them to give instant feedback. People love getting

feedback on their photo uploads, be it comments, likes or shares. This is what drives people to constantly snap away photos on their phone and share them. In June 2018 Instagram announced that it had 1 billion users on its platform. 1 billion users sharing photos. Social media photo sharing has allowed people to connect with other complete strangers from all over the world. The hashtag (#), a type of metadata tag, was specifically introduced to allow social media users to share content tagged to a specific topic or subject, making it easier to connect with other users from across the globe interested in that same topic.

Visitors who find the museum fun and interesting would want to share their experience with others, especially family and friends. Through their photo uploads they want to let them know that they are having fun, and that they are doing something worth sharing.

In order to encourage visitors to share photos of their visit to the museum and specifically the Dürer Gallery, I designed the #MEETDÜRER photo opportunity. This free-standing cutout depicts three characters. Dürer in his full costume is in the middle and on each side are two characters who appeared in the trailer mentioned earlier. These two characters, a male and a female, have their faces cut out so that the visitors can stand behind the cut out and place their face into the hole appearing as if they were dressed in the medieval costume. The idea behind this photo opportunity was my belief that the general public would prefer posing for a photo in costume rather than next to a Dürer print. People taking this photo would want to share it on their Facebook or Instagram pages. Friends are bound to ask them where it was taken (if the user omits this information in their post) and this should get mentions of the Mdina Cathedral Museum and possibly of their experience within the Dürer gallery.

Although the popup is not a digital tool in itself, it is a simple example of how user generated content (derived from the shared photos) can be an effective marketing tool.



Figure 4.3 - Photo showing the PVC cutouts allowing two persons at a time to place their face in it.

Source: Taken by myself.

4.3.4 The One | Six Exhibition

At the end of the two-year Master of Fine Arts in Digital Arts programme, at the University of Malta, students showcase their research in an end of course graduate show. One | Six is an exhibition bringing together six Masters in Digital Arts students whose research and practice cover

a wide range of topics including memory, ethnography, dystopian realities, the archive and museum experiences.



Figure 4.3a - Photo left: photo of the test print of the exhibition catalogue.

Figure 4.3b - Photo right: part of the setup at the exhibition showing the interactive touch unit and the video projection.

Source: Taken by myself.

The exhibition was promoted mainly online, through the One | Six Facebook page, post sharing, and mass email shots. A high quality A5 sized event catalogue was produced showcasing information about the exhibition in general and about each individual work and artist. The exhibition was launched on the 1st of June 2019 at Space C at Spazju Kreattiv, St. James Cavalier.

The #MeetDurer project helped me demonstrate how digital tools can be used to effectively make the visitor experience more interesting. The fact that I was able to test this in a museum environment was a unique opportunity to test visitor reactions and results in a real setting. The project above clearly demonstrates the importance of designing experiences built around the visitor's needs, and how narrative turn digital tools into effective tools in the hands of the exhibition designer.



Figure 4.4a -Photo left: an intrigued young girl having a try at the interactive Dürer unit.

Source: Klitz Klitz Photography.

Figure 4.4a - Photo right: Fellow exhibitors were the first to try out the Dürer cutouts and pose for a photo.

Source: Taken by myself.

A copy of related artworks, a digital version of the catalogue and photos from the event launch can be found on the USB in the Appendix.

5. Discussion of Findings

In the methodology section of my thesis I explained how I used different qualitative research methods to collect different data to help me investigate the use of digital tools as an integral part of the visitor experience in a museum. Digital tools, as the name implies, are instruments used to perform a task to achieve a specific purpose. A knife can be a very useful tool only if it is used well, the incorrect use of that knife will cause more harm than good. Only knowing when, where and how digital tools should be used, will ensure that they achieve the desired results in effective museum interpretation. Digital tools cannot be investigated in isolation and so one needs to look at a much bigger picture when designing museum visitor experiences.

For this investigation to make sense, the analysis has to be carried out while taking into consideration a variety of factors at play in the current museum / audience realities. In the two and a half years of my research journey I wanted to look into these influencing factors in order to better understand the where, when and how digital tools could be used. As explained in the introductory chapters of this thesis, my research is not about a specific type of digital technology, but rather about the best approach in the use of any of the variety of digital tools that may be available on the market today in order to improve the visitor experience.

In order to understand the wider picture of the museum environment where these digital tools will be implemented, my research looked at five key issues, these being; Contemporary museology trends, museum audiences, museum learning, digital tools and exhibition design. My research over the last two and a half years has shown that these five issues are very much interrelated and it is difficult and impractical to discuss them in isolation without appreciating the context and also the effect they have on each other.

Contemporary Museology Trends

Over the last century, museums have undergone two major revolutions; the first happened in the early 1900s when museums became institutionalized and also more professional. The second revolution often called New Museology happened around the 1970s when collections-based museums were being replaced by a functional, centred approach. This contemporary museology approach and its focus on the visitor experience brought about significant changes in exhibition design, whereby the artefact became secondary to the message (Alt et al., 2012). The current increase in the social accountability of museums, their increased role of facilitator and heritage's use for social development have led some to claim that museums are going through a third revolution (Van Mensch, 1992).

New museology came about as the result of the wish to open up museums to wider audiences and change the impression that museums were mainly for the educated and prosperous few (Vergo, 1989). This had isolated them from the real modern world and turned them into a waste of public funds. Traditional collections-based museology was focused more on museum methods, and often neglected the real purposes of the museum. Contemporary museology is all about opening up museum experiences to a wider audience and increasing access, social inclusion and participation by visitors at all levels.

Contemporary museology has brought significant changes in 'value, meaning, control, interpretation, authority and authenticity' in museums (Stam, 1993). As Stam states, new museology has brought about a completely different understanding of the relationship between museums and visitors including communities. This new trend of museum design and approach has changed the museum environment from a top down authoritative, curatorial approach to a bottom up visitor-centred, dialogue approach. Over the last decades, museum approaches to

visitor access and engagement have been significantly influenced by such concepts as the ones discussed in the *Engaging Museum* (Black, 2005) the *Responsive Museum* (Lang et al., 2006) and the *Participatory Museum* (Simon, 2010). Museums have turned to digital tools as key tools for visitor engagement and museum democratization (Drotner & Schröder, 2014) .

The Mdina Cathedral Museum, where much of my research work was conducted, is one clear example where the museum is slowly but steadily transitioning from the traditional collections-based museum approach to a more visitor-centred humanistic approach. Some of the projects I proposed and implemented over the last two years, such as the *Autism Friendly Museum* project, the *DressMeUp*, the *informal learning area* project and the setting up of the temporary exhibition zone within the museum, which are covered in my methodology in Chapter 3, are all examples of how the museum is becoming more function based and less collection focused. The museum is also opening up to new audiences previously not targeted or welcomed. For the first time the museum is realizing that there is not one audience body but various different audiences with different needs and expectations that need to be catered for through more personalised museum services and experiences. Apart from introducing new digital tools, like interactive screens and audio guides, work is being done to make the museum more welcoming and comfortable. Projects such as the redesign of the main ticketing and reception area, the setting up of new toilets on all floors, of a cafeteria and souvenir shop and increased seating make the museum more visitor friendly. In view of these changing realities museums are turning towards digital tools as an attempt to take themselves into an age of increased democratization (Taylor & Gibson, 2017).

Visionary academics in the late 1960s, like William J. Paisley from Stanford University, imagined museums where technology and digital tools shaped the museum experience of future visitors. Sitting down at the computer terminal within the Jewelry Gallery at the Victoria and Albert museum in London exploring the full collection of thousands of jewelry artefacts in their collection, reminded me of what he had imagined for future museum visitors who would be able to use a computer terminal and research all the works on display as well as those in storage or in travelling exhibitions.

Over the last years, museums have embarked on a digital transformation process. They have started using digital tools and technology driven processes for a wide variety of purposes aimed at improving their operational efficiency. Some examples include: using digital collections management systems to better manage their assets and using the web, gamification, digital apps and technologies such as AV and AR to better engage audiences. Artefact digitization, virtual exhibits, web searchable collections databases have become commonly available. Museums now extensively use social media to promote events, collections and exhibitions and are increasingly turning to e-commerce to sell online tickets and merchandising in order to generate income.

As Parry Ross (2013) writes, digital tools and technology have become so normalized within the museum sector that we now need to start looking at museums in the post digital . In this era digital has infiltrated all aspects of museology and has become embedded in the institution's core activity, rather than a specialized isolated activity department. In a post digital museum, Parry asserts, a museum not only accepts digital but starts to actively use digital to achieve the museum's goals. One such post-digital museum that I visited was the 'Museo del Risparmio' in Turin which managed to create an engaging highly educational visitor experience using exclusively digital tools and no physical artefacts.

In my research visits to the different museums and historic sites, however, it became clear to me that not all institutions share this reality. Some museums are still struggling to accept these new approaches to museology let alone to move to the post digital reality. The bad use of digital tools at the Fortifications Museum in Valletta is one clear example of how some museums have chosen to use digital simply for the sake of using digital tools rather than in an effective way of reaching institutional goals.

Leaders in the museum sector such as the British Museum are moving towards becoming a platform where ideas and audiences engage with each other in different ways. The platform extends between the physical and digital and covers the pre, during and post museum visit.

Museum Audiences

Museum visitor research spans many different disciplines including sociology, architectural studies, social psychology and anthropology (Macdonald, S., 2007). Museum audiences have been classified in different ways. Rather than looking at the meaningless traditional, demographics based statistics as a way of classifying visitors, I have tried to identify visitors using Falk's categorization by visitor needs and their expectations from museum experiences to create five different categories of users, that is, explorers, facilitators, experience seekers, professionals and rechargers (Falk et al., 2016). This new way of looking at audiences, including an increased awareness of audience diversity, is in line with the visitor centred, humanist approach of new museology (Ross, 2004). Museums like the Mdina Cathedral Museum often gave very little importance to audience development. Their main audience consisted of tourists,

and no efforts were made to differentiate between the needs of the group tourists and those of individual tourists, whilst local visitors were hardly considered at all. Museums whose main target audience are tourists, as is the case with museums in Malta, often fail to look into audience classifications and consider themselves more as attraction centres rather than learning centres. For a museum to use digital tools to create visitor engagement, it must know who its existing and potential visitors are, and have a very good understanding of their needs and expectations.

Digital tools are changing the way visitors engage with museums. Advances in technology move in parallel with the audiences' behaviour especially in the case of younger audiences. The shift in the museums' focus brought about by the new approaches to museology discussed above has also meant that audiences have evolved from being passive receivers of culture to active participants wanting to interact and give feedback. Today's museum audiences do not simply appreciate art and culture but seek to manipulate, create and adapt their own interpretation.

Technology allows museums to attract new audiences, particularly those who might have previously felt that museums did not interest them, by providing them with a new or deeper way of engagement. Technology and trade have helped create a globalized society which in turn has created audiences that are more diverse both demographically and culturally. Museums have to respond to this new reality by moving beyond their traditional communities and reaching out to visitors beyond their boundaries (Hargrave & Mistry, 2013). There are a number of factors that are influencing changes in existing museum audiences. These include: the younger digital native generation, changing lifestyles, aging populations and an expanding global middle class.

Today's younger digital native generation live using digital tools in almost every daily chore and activity. Even the very young are completely at ease, using tablets, browsing for

information, continually posting and interacting on social media and watching streaming videos. This generation has unique characteristics in the way it looks at and processes information. In all the museum projects I was involved in there was a big gap between the museum professionals and curators and the younger generation of users. Many curators I met have never used Snapchat and some don't use Facebook and Twitter. Bridging this gap is essential in order to acquire an understanding of the expectations of younger audiences.

On the other end of the age spectrum, particularly in Europe, one finds an aging population, the result of increased life expectancy and lower birthrates. Museums must therefore consider aging populations in their design and visitor experience. The use of digital tools must take into consideration older users. My experiment with *Cathedra*, whereby visitors to my installation had to make use of the interactive touch screen to explore the inside of the Mdina Cathedral, proved that older users found it relatively easy to use such a screen as it was very similar to using a smart phone's touch screen. This does not mean, however, that other forms of more innovative digital tools such as AR and VR or more complex immersive experiences might not be more challenging to older users.

In my professional work in the web sector, I sometimes get requests from SMEs wishing to set up an ecommerce site to start selling their products online. Speaking to some of the business owners, I often realize that most of them have never purchased anything online and have absolutely no idea about the needs and expectations of online customers. Whilst they think that such issues are not important in their business plan, I ask them whether they would open a shop in a far away country where they do not speak the language or understand the culture of the buyers. They always reply that they would never make such a move, and, immediately, they realize that they cannot sell online if they know nothing of their online customers' needs and

expectations. This analogy is very similar to museums that try to implement digital tools without knowing much about the technology but, even worse, about the visitors' needs and requirements.

The neo humanist museum, resulting from the new museology revolution, must place a lot of emphasis on the individual's experience. Understanding the different users' needs, expectations and limitations will help museums create experiences which move away from a one size fits all model. During my observation of visitors to the digital installations I set up, and at the various museums and historical sites I visited, I looked at visitors not as tourists or locals but as explorers, facilitators, experience seekers, professionals and rechargers. I was particularly interested by families, especially those with younger children. As a parent myself who visits many museums with my two daughters, I was instinctively on the lookout for museums which provided truly engaging experiences. One such experience for families was offered at the Museo Egizio, where the museum not only set up specific trails for families, but had its own hands-on learning centre within the museum. Families who visit the museum can use this learning centre to rebuild machines and models using blocks in an exercise that not only reinforces what they have seen but also teaches them basic concepts related to science, physics and engineering. As I observed families engaging in such a relaxed and fun environment, I could not help but notice the good time that children were having in activities with their parents; no one was looking bored and no mobile phone or tablet was to be seen. Such an experience will surely allow visitors, both adults and children, to take away with them many positive memories of their experience leading to potential constructivist learning.

My visit to the Bishop's palace at Wells Cathedral was my inspiration to design and implement the *DressMeUp* project at the Mdina Cathedral Museum. Having tried out dressing up in costumes myself whilst visiting the Bishop's palace, I found that this provided a completely

different fun approach to a visit to what might have been a pretty boring historical site. In fact, at this location there were no digital tools available, but the dressing up in costumes made up for the lack of digital tools for Interpretation. The experience was so positive that I carried many fond memories of the place well after I left it. It was so effective in fact that, later on when I was back in Malta, I looked up the Cathedral and the Bishop's palace online and read more about the venue.

Museum Learning

Museum learning occurs not only within the physical museum but also outside, in the virtual world. As early as 2002 the number of virtual museum visitors had already exceeded that of visitors to physical museums (Hawkey, 2004). There is extensive literature on learning in museums e.g. (Hein, 1998; Falk et al., 2002; Moussouri, 2002; Hooper-Greenhill et al, 2003).

When educational theory is applied to museums, we also get different types of museums at each end of the spectrum. When combining realism and incremental learning to a *tabula rasa* one gets the systematic museum, which believes that the museum exhibits reflect the true knowledge on the subject matter, and the content in such exhibits is presented in such a way that it is easy to be understood by the user. The paintings gallery within the Mdina Cathedral is chronologically arranged starting from the 13th and 14th centuries, moving on into the Renaissance period and subsequently into the 18th and 19th centuries. This makes it very easy for the user to comprehend how paintings evolved over time. Even the numismatic collection within the same museum is organised along a chronological timeline, thus explaining how coins changed from Punic to modern times. On the other hand, when museums adopt a constructivist

approach to visitor education, it is believed that visitors build knowledge from the exhibits, making the gaining of knowledge a constructive act in itself (Hein, 1993).

The way the British Museum's Money gallery (Orna-Ornstein, 2001),(Cribb, 2001) is designed is completely different from the setup of the Mdina Cathedral Museum's money gallery. Rather than taking a chronological approach, the designers have taken a thematic approach based on people's concepts and impressions of money. This exhibit has no fixed entry and exit point and visitors can randomly roam along the different display units in the gallery. This allows the user to reach his or her own conclusions, through the user's own associations between the material on display and his or her own way of learning.

The constructivist approach to museum learning fits more into the contemporary museology style of placing the visitor at the centre of the museum experience. Constructivist museums approach learning in the form of a constructive dialogue instead of a passive process of transmitting knowledge. Such museums do not act as know-it-all experts but take the role of privileged participants. Constructivist museums encourage a lifelong, free-choice learning approach. (Falk & Dierking, 2016) .

Digital Tools

Since the 1980s, museums influenced by the new museology started taking a different approach to how to convey exhibit information to a wider public focused on the context of a cultural artefact rather than simply on the object itself (MacDonald et al., 1991). 1994 marked an important milestone for digital tools in museums. In fact, two important developments marked a new era for museology. The audio guide already in use in museums went digital (Proctor &

Tellis, 2003). During the same year the first museum website, that of the Natural History Museum in London, went live (Shaw, 1995).

Digital technology has permeated every aspect of museum life. This occurred in some cases more than others. During the various site visits I made all over Europe, I could see the different levels of how museums have adopted digital tools as a means of enhancing the visitor's experience of the museum. The technology behind these tools is continuously changing and improving. This technological advancement in such tools is not by itself a strong enough reason to install them in a museum. A clear understanding of visitors' needs and expectations is what is needed to determine which digital tools to choose and how these should be implemented to ensure a more rewarding visitor experience (Tallon & Walker, 2008). Today's museum visitors are more authors than audiences, wishing to participate in meaning making and the creation of content (Keen, 2007). Digital tools are attractive to museums because they can deliver meaningful information according to the individual's needs through new interactive experiences. Yet many museums are still struggling to incorporate new digital technologies into their exhibition designs (Taxén, 2005).

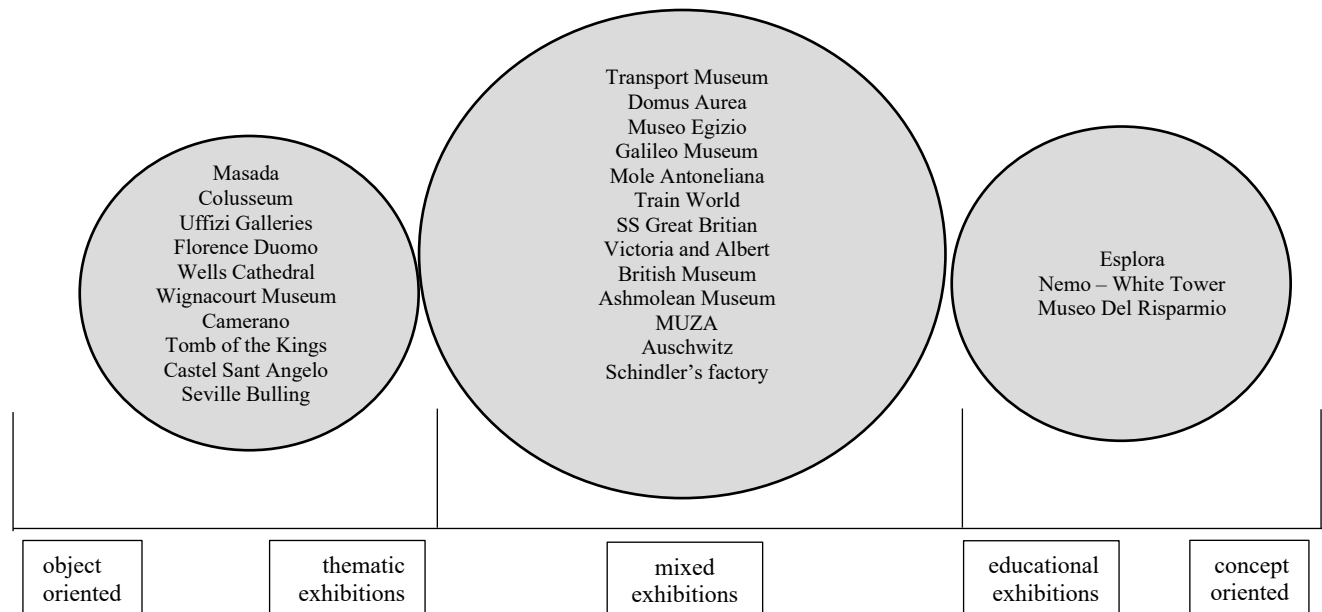
Throughout my research I was able to use, experiment with and review various digital tools; these included audio guides, touch screen info screens, projection and directional audio, AR and VR, mobile apps and the web, including virtual museums and social media. Their use in Museum settings was made easier by significant improvements in hardware and software as well as a decrease in costs. Digital tools offer effective solutions to issues of space limitation which is very often an issue with most museums. They are viewed by museum curators as an ideal tool to engage with visitors in innovative ways. Collection digitization is being undertaken not only to preserve cultural heritage but also to make this content accessible to a wider audience in a more

attractive manner (Styliani et al., 2009). The project of digitizing the numismatic collection at the Mdina cathedral museum and the plan to make this collection available to the general public via the web would make this collection much more accessible to the general public than was ever possible before. Discussing how the audio guide setup at the Music exhibition at the Mdina Cathedral Museum or the Crusaders Fortress at Acre could have been better set up to work more smoothly or how the Albrecht Dürer touch screen increased visitor time in the hall from less than a minute to more than three minutes as well as other individual examples resulting from my observational research at site visits would be interesting. In this way, however, only individual installation-based issues would be targeted rather than the bigger picture of using digital tools for enhancing visitor experiences in museums. Having said that, my extensive research, visits and experimentation have reinforced my belief that digital tools are not being effectively used in museums for a number of reasons which need to be tackled before significant changes can be seen. Despite the fact that museums have been trying to introduce computers and digital tools for the last fifty years, in the majority of the museums I visited there exists a widespread feeling that the sector lacks a sense of digital confidence. My research has shown that this lack of digital confidence exists because of an existing mindset which considers digital skills as pertaining to a specific IT technical skills sector/unit often found outside of the museum or in a separate IT department rather than skills needed by the organization as a whole. A siloed departmental approach with the lack of a multidisciplinary team approach to digital projects continues to reinforce this mindset. For museums to be able to implement digital projects, irrespective of the digital tool involved, they need to take a completely different approach, work as team, and understand that digital projects should be born out of visitors' needs, and understanding those needs is what is crucial for the successful implementation of any project.

Exhibition Design

The two digital installations *Solitude* and *Cathedra* as well as the museum exhibition projects I was involved in, *Nemo* at White Tower, the Birkirkara Basilica museum, the Money Gallery redesign and the Albrecht Dürer project at the Mdina Cathedral Museum, helped me understand and appreciate the complexities, challenges and requirements of effective exhibition design.

Commercial exhibitions are set up with the ultimate goal of selling a service or a product. On the other hand, museum exhibitions are meant to inform and engage the public and as a result change attitudes and behaviors (Velarde, 2017). With reference to the meaning of ‘museum’ as discussed in Chapter 1, if a museum is really an abode of the muses, that is a place of reflection, study and learning, then museum exhibitions have the clear mission to provide the space and place for education and reflection (Dean, 2002). The primary reason for museum exhibitions is to provide the artefacts and information required for learning to occur. The inclination of museum exhibit designers to use digital tools as part of the exhibit design comes from the ability of digital tools to provide visitor centred engaging mediums of information transfer. Although museum exhibition displays would normally be built around collections or at least artefacts on display, this is no longer necessarily the case. The White Tower exhibition area on marine biodiversity, described in Chapter 3, did not use one single artefact and the experience was completely based on the content found in the digital tools displayed. The same goes for the Museo del Risparmio, App 3.5.2, where the museum’s permanent exhibition area was completely based on digital tools. As explained in chapter 2.6 Exhibition Design, thematic, educational or mixed type exhibitions fall between two extremes of object oriented and concept oriented setups and approaches.



The above table shows how some of the museums I visited fit into the exhibition design type scheme discussed in the literature review. The majority of the museums visited lie in the centre of the spectrum, most having a mix of thematic and educational exhibits. Heritage sites visited are at the extreme of the spectrum very often not because they just focus on objects but because they lack interpretative information. “Interpretation is the act or process of explaining or clarifying, translating, or presenting a personal understanding about a subject or object”(Dean, 2002).

The more visitor centred the museum and its exhibition design is, the more towards the middle right of the spectrum would it stand. All museum exhibitions, irrespective of where they stand on the display spectrum, have at least one thing in common: the wish to communicate to visitors. The quality and approach to the exhibition design has a direct impact on the visitor experience.

As stated earlier, my observational studies of museum visitors could not look at digital tools on their own, but as part of the overall exhibit design and its impact on the visitor experience.

Visitor centred museums that managed to engage the visitors through interactive exhibits were the ones most appreciated by visitors. The Galileo museum in Florence, App3.5.2, contains a priceless collection of scientific instruments from the Medici collection, once on display in the Mathematics Rooms of the Uffizi Gallery. These tools, spectacular as they might be, are quite meaningless to the common visitor who does not know how they work. The museum used a variety of tools to explain through visitor participation how the different tools work. Through a number of hands on experiments and multimedia content available on screens as well as on a mobile app, visitors can understand and interact with the different concepts discovered and elaborated on by Galileo. Visitors, especially families, could be seen trying out each of the interactive exhibits, and using the app to understand the concept further. I could clearly see that these visitors were very engaged and enjoying their visit in the museum.

Brunel's SS Great Britain museum ship is another great example of engaging exhibition design, APP2.4.6b. The museum has a mixed approach taking both a thematic and an education exhibition design approach. The museum focuses on the subject of Brunel's genius, particularly that related to ship building, the iron hull and the propeller replacing the steam paddlewheel. The exhibit design engages users to enroll themselves as crew or passengers of the ship and discover the different themes covered by the museum. The museum uses reward-based gamification not only to engage the user but to explain important concepts related to ship hull, speed, buoyancy, stability and propulsion. Rather than shoving concepts down visitors' throats it allows them to experiment with different designs and try out concepts, a bit like Brunel

experimented with different propeller designs. The exhibition designers use all the elements of meaningful gamification including play, exposition, choice, information, engagement and reflection (Nicholson, 2015).

One of the most engaging exhibition setups which I experienced was the British Museum money gallery, specifically the coin handling session. Although this part of the exhibition did not use any digital tools, visitors loved handling the money artefacts under the supervision of the gallery volunteers. Visitors were clearly very pleased to explore the surface and weights of different types of coinage being handled. I could hear people discussing stories related to the coins' previous owners as they were intrigued by the fact that they were actually handling the same coins originally handled by their owners thousands of years before them. Participants experienced an authentic sense of discovery and genuine excitement similar to that observed at the Hunt Museum described in their paper by Cioffi and Bannon *Designing Interactive Museum Exhibits!: Enhancing visitor curiosity through augmented artefacts* (Cioffi & Bannon, 202). Museum artefact handling is clearly very exciting and engaging for visitors but not all artefacts can be handled without running a huge risk of damaging them. 3D scanning and 3D printing could be used to create replicas which can be safely handled by visitors. Object manipulation and tactile perceptions are an important part of interpretation and understanding of museum artefacts (Dudley, 2013). Museums have started experimenting with 3D printing of artefacts presented to the public. This has led to two important museum exhibition changes. The first is direct physical interaction by visitors with objects on display breaking away from the sacred rule of 'see but don't touch' and at the same time visitors have started to appreciate the fact that museums present inauthentic (through technology generated replicas) but accessible artefacts (Di Franco et al., 2015).

Museums adopting a bottom-up visitor-centred approach cannot rely on the curator alone for designing exhibitions. The different projects tested in my research has clearly shown that the inter-disciplinary approach was crucial for their success. Museum experience design relies on the collaboration and input of different professionals working together as a team. This is true not only for the implementation of digital tools but for any museum exhibit / experience design. Curators, designers, programmers, developers and marketing specialists led by the exhibition designer need to work together to create effective museum visitor experiences.

New museology trends are pushing museums to design exhibits which are more visitor focused. Integrating digital tools in such exhibits is for many museums the most effective way of drawing users' attention and engaging them with the exhibits. From the visits I carried out in museums abroad and in Malta it is also clear that many museums have limited knowledge of how to design technology from a visitor-centred point of view. On the other hand, human-computer, particularly gaming, software design has a very strong tradition of involving users in the design process. It is clear that museum exhibit design needs to take a multidisciplinary approach bringing together the curators and museum experts, graphic and UX designers and software developers. The lack of understanding of user experiences when designing interactive displays is clearly manifested at the Fortifications Museum in Valletta. This museum, designed to showcase the vast fortifications around Malta, particularly around Valletta, was an EU funded project. Here the content placed within the various interactive screens within the museum failed to capture the visitors' imagination and interest. The presentation showed very little concern for visitor usability using the limited interactivity of Microsoft's Powerpoint to power many layers of content which were difficult to navigate. Whilst the content on the screens was very rich in historical facts, having been prepared by the museum's curator, it lacked the multidisciplinary

approach of involving graphic experts and designers. On the other hand, the SS Great Britain game not only managed to engage visitors to use it but provided a fun entertaining element to allow visitors to discover and learn concepts related to ship hull design and propulsion.

In my research I have also identified a methodology which fits perfectly into this multidisciplinary team approach for museum exhibit design. This is the Design Thinking methodology by Stanford University (Von Thienen et al. 2018). I first came across the use of this methodology in a museum setting at the Museo Egizio where it was used for a redesign of the audio guide experience. Later, I used this methodology myself in the *#MeetDurer* project for the present Master's degree. The biggest advantage of Design Thinking methodology for museum exhibit design is the fact that it takes a multidisciplinary approach where various points of views, including those of the museum staff and users, are taken onboard in the design. One of the strongest elements of this methodology is prototyping, which ensures that even technology driven projects are designed from the user's point of view. Design thinking methodology offers huge potential for the design of museum experiences which are visitor-centred and capitalize on the expertise and input of a multidisciplinary design team (MacLeod et al., 2015).

During the numerous visits to museums and interpretation centres all over Europe I could see there were major differences in the way certain museums met basic visitor needs. During my visit to the Vatican Museum, the sheer size of the building, the huge crowds, the lack of easy to follow signage and the very little, if any, interpretative material had a strong impact on the overall visitor experience. Orientation is not only important to let visitors know where they are but it helps them focus on the message the museum wants to deliver (Hein, 2002). Although a physical museum environment which is comfortable for the visitor will not guarantee people's learning, yet it is a necessary condition. The fact that in many museums, you find ice cold

galleries, lack of seating facilities, lack of signage including wayfinding and lack of toilets or refreshment areas, sometimes offsets the benefits to modernize interpretation and visitor engagement through digital tools. The Uffizi gallery was a similar experience. There was very little narrative and engaging interpretative material. Visitors just moved along looking absent minded at the priceless treasures on display, appreciating art as much as a drunkard would appreciate a good wine after a whole day's drinking. In both museums I could see many visitors, especially tourists, simply looking for a place to sit and rest their tired feet whilst completely ignoring the artefacts on display. It may very well be that, when museums use visitor numbers to measure their levels of success, they are failing their visitors. It could also be that the curators of the Uffizi one of the world's most popular and important museums feel that those who visit should know what they're in for and thus put little emphasis on interpretation. It could be that they believe that as long as the huge volumes of visitors continue paying for the entrance fees then they do not need to bother with improving interpretation. If this is the case, then it is proof that the financial aspect is not the right guiding principle for measuring the museum's effectiveness. Some international museum sites like the Vatican Museum, the Uffizi and the Louvre are so popular must-see locations attracting millions of tourists every year that they put little effort into the mission of constructivist learning. Some of the smaller museums that I visited such as the Museo del Risparmio, the Museo Egizio, the Galileo Museum, SS Great Britain and Trainworld took a very visitor-centred approach trying to create a fun and comfortable environment that leads to a strong hands-on and participative learning experience.

Whilst visiting the Vasari Corridor at the Uffizi gallery, I stopped to look out of one of the panoramic windows which had been installed for Adolf Hitler to be able to enjoy the same view of the Ponte Vecchio and the river Arno. This is, for me, one of the most iconic and

beautiful bridges in the world, full of history and charm. Around me were lots of tourists taking selfies with the bridge and scenery in the background. Without thinking, I asked them if they knew any stories related to the bridge. Taking me for some sort of museum docent, they replied they did not and, uninvited, I proceeded to tell them about how the Italian poet Dante had first seen Beatrice standing on the bridge, a vision that made him fall completely in love with her and how Beatrice later died, carried off by the plague. Dante was terribly stricken with the loss of his vision. She was the connection between his soul and Heaven itself, and from this the Divine Comedy was born. Without pausing, I told them another story which happened six hundred and fifty years later, during World War II, as the Nazis were fleeing the Americans who were chasing them up the Italian peninsula. The story was about how the bridge was saved by a gentlemen's agreement between a German Commandant and the Americans. When I finished, they were all looking at me, some looking back at the bridge they had been snapping photos of with their smart phones. It was as if the bridge had taken a new meaning after the story and become a million times more beautiful and important. Most of them thanked me and walked away. A somewhat elderly gentleman approached me and in broken English said thank you for my story, it being the first thing he had managed to understand in the whole museum. This single small episode was one of the biggest eye openers in my research and all my museum visits. The tourists were in one of the most important museums in the world, a museum packed with priceless artefacts collected over hundreds of years, and produced by some of the most important artists mankind has ever seen. Yet the museum failed to engage with them, only the picturesque scene of the Ponte Vecchio had captured their attention and my uninvited story made them appreciate it even more. The story had allowed them to somehow connect with the scene. This is what museums should be doing all the time, in all the galleries and exhibits they put on show.

Many museums are run by academic curators who can only communicate through academic papers and unfortunately not by storytellers. One can find a parallel situation when comparing this situation with film makers. One can ask, why is it that a film about an artist is more popular than his paintings? The comparison between the narrative of museums and that of film is interesting and also important to the way that we should be experiencing museums. Museums should engage with visitors, and digital tools can contribute to constructivist learning within museums.

In a world of fake news, museums remain the beacon of truth not because some curator is saying so but because people can visit them and form their own opinions about what is good and what is wrong (Harrison, 1994).



Photo of Ponte Vecchio reflected in the river Arno, taken on the 28th October 2018 just after I had blurted out my explanation of the Dante and WWII story of the bridge. Source: Taken by myself.

6. Conclusion

Museums offer a glimpse into humankind's purpose of existence on this earth. Through museum collections, man looks at the past in an effort to find existential meaning for the future. Museums facilitate the creation of meaning between the viewer and the artefact. We are fortunate to be living in exciting times when museums are reinventing themselves. The visitor-centred ethos of new museology is revolutionizing the way museums present themselves to their audiences and significant efforts are being put into making them more accessible to everyone. Within this exciting scenario museums are turning to digital tools to improve the way they attract, and communicate with, their existing and potential audiences.

Throughout the last two and a half years, I have tried to involve myself as much as possible in the museum world. This has been done by visiting different museums all over Europe, joining EU projects related to museums and cultural heritage as well as proposing and implementing, within local museums and cultural heritage sites, a number of projects in the area of visitor engagement and interpretation. During my research, whether in a corner of a museum gallery observing visitors or designing museum experiences, I came in contact with all the different issues covered by the literature review, such as museum audience studies, contemporary museology approaches, and the variety of digital tools being put to test or in practice.

Research has shown that museum audiences offer a rich and complex picture. Understanding what motivates museum visitors to visit or not to is a key factor in being able to design effective museum experiences. The time spent visiting museums all over Europe meant that I could appreciate firsthand how properly designed exhibitions engaged visitors but also learn from the pitfalls of bad exhibit design which failed to place the visitor at the very centre of

the museum experience. Successful visitor engagement is not dependent on museum size or popularity. Indeed, some of the biggest and most popular sites visited offered the least engaging visitor experiences, showing that visitor volumes or financial returns are not enough to measure how effectively museums are fulfilling their core role as learning institutions.

Museum learning offers many challenges and opportunities as it is very different from structured formal learning. The Constructivist museum places the focus on the learner rather than the subject to be learnt. Within Constructivist museums, the visitor creates knowledge using personal learning methods and enables the museum to cater for all ages of learning.

My research has shown the importance of taking a multidisciplinary approach when designing and implementing museum projects. The new visitor-centred museology trends have changed the power dynamics within museums. Curators now have to work hand in hand with exhibition designers, developers, installers and IT experts. Experience in implementing some museum pilot projects has shown, however, that some organizations might not easily accept this change in approach thus making it extremely difficult to implement visitor-centred exhibition designs.

Design Thinking methodology was effectively used in all the museum projects to create experiences that appealed to a variety of visitors. This methodology is at the heart of a visitor-centred approach which encourages museums to be more socially responsive and inclusive. Design Thinking methodology is an ideal approach to help design museum experiences in the future especially those incorporating digital tools for interpretation.

Advances in technology and generations of digital natives offer huge potential for digital tools to be effectively used in museum interpretation and visitor engagement. For this technology to be effectively used, an understanding of the underlying museum realities such as

museum audiences and learning as well as a multidisciplinary approach in implementing them are needed. In the coming years technologies such as mixed reality, 5G, gamification and AI will be offering new tools which will completely change how we experience museums. These emerging technologies emphasize the need for different specialists from different fields to work together in the area of museum interpretation and visitor engagement.

This research journey has provided me with a unique experience to learn more about a sector which I love, enabling me to understand how to bring museums closer to their audiences and making them more attractive to them, how to make visiting museums fun for everyone and how to help museums fulfil their important educational role and influence society to become better. I look forward to implementing my research into more real-life museum projects and to using this research as a basis for more advanced research into the better use of digital tools in museums.

6.1 Limitations and Recommendations for future Studies

As one can see from the Methodology chapter, this research was carried out in parallel with a number of hands-on projects, installations and experiments that reinforced the rationale underlying the research. My practice as a multimedia designer, my interest in digital art as well as my role as a parent have definitely influenced my approach towards carrying out this research.

Malta's museum scene is a relatively young one, and sometimes being able to find practitioners with whom to discuss new concepts such as new museology and museums in the post digital age was quite challenging. Working with conservative and traditionalist institutions such as the Mdina Cathedral Museum was not easy at all, as I never imagined the amount of reluctance and distrust I would face. Luckily this limitation was offset through my participation

in COST projects and attending Training Schools and conferences abroad. Through these events and activities I managed to network with top professionals from all over Europe.

The use of digital tools in museums is relatively new locally so my research had to focus on what was happening in the sector abroad. My research focuses on technology for improving museum interpretation and visitor engagement. In order to avoid technology obsolescence, I decided to focus more on methodology and best practices rather than on individual technologies which would probably become obsolete within the next five years.

Financial and resource constraints were also a limiting factor for the number of experiments, projects and travelling I could carry out during the course of my research. Technology can be very expensive, especially when dealing with innovative new products and solutions. The Cathedra and Solitude installations were considerably expensive to carry out and with more funds I would have experimented more with VR and AR as well as with directional audio and large format projections. Luckily, I managed to tap into and obtain funding through local or EU programmes to help finance my research. Without such funding I would have found it close to impossible to convince museums to try out the projects that I proposed. It is my intention to secure more funding to continue developing my ideas for interpretation using the latest digital tools.

The conclusions of my research are for the most part practical and can be implemented in real life museum projects. It is hoped that the research brings together different professionals to work together as a multidisciplinary team in the execution of these projects. In today's information age, technology has permeated every aspect of our daily lives. It is recommended that further research into these emerging technologies is carried out in order to make museums

more attractive and accessible to the widest audience possible. In today's visitor-centred museology approach, this research must also focus on the users of the technology.

References

Access programs - Whitney museum of American art. Retrieved from

<https://whitney.org/WatchAndListen/Access>

Agency, I. C. D. (2017, -10-26T14:46:51.923Z). How we helped the Museo Egizio of Turin to re-think its audio guide using design thinking and paper.... Retrieved from

<https://medium.com/@invisiblestudio/how-we-helped-the-egyptian-museum-of-turin-to-re-think-its-audioguide-using-design-thinking-6a27b080b3de>

Alt, M. B., Gosling, D. C., & Miles, R. S. (2012). *The design of educational exhibits* Routledge.

Ambrose, T., Paine, C. (2018). *Museum basics: The international handbook* Routledge.

American Association of Museums. Task Force on Museum Education. (1992). *Excellence and equity: Education and the public dimension of museums; a report from the American association of museums, 1992* American Association of Museums.

Angrosino, M. (2007). *Doing ethnographic and observational research* Sage.

Aoki, P. M., Grinter, R. E., Hurst, A., Szymanski, M. H., Thornton, J. D., & Woodruff, A. (2002). Sotto voce: Exploring the interplay of conversation and mobile audio spaces. Paper presented at the *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 431-438.

- Arth, C., Grasset, R., Gruber, L., Langlotz, T., Mulloni, A., & Wagner, D. (2015). The History of Mobile Augmented Reality. *arXiv Preprint arXiv:1505.01319*,
- Atieno, O. P. (2009). An analysis of the strengths and limitation of qualitative and quantitative research paradigms. *Problems of education in the 21st Century*, 13(1), 13-38.
- Aukstakalnis, S., Blatner, D., & Roth, S. F. (1992). *Silicon Mirage: The art and science of virtual reality*, Peachpit Press Berkeley, CA.
- Azuma, R., Bailiot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. *IEEE Computer Graphics and Applications*, 21(6), 34-47.
- Azzopardi, J. (2018). *Dürer in Malta*: Midsea Books. Malta.
- Azzopardi, J., Malta, H. S., Buhagiar, M., & Week, H. (1982). In Buhagiar M., Malta Historical Society(Eds.), *Count Saverio Marchese (1757-1833) : His picture-gallery and his bequest to the cathedral museum*. Malta Historical Society.
- Bannon, L., Benford, S., Bowers, J., & Heath, C. (2005). Hybrid design creates innovative museum experiences. *Communications of the ACM*, 48(3), 62-65.
- Barsanti, S. G., Remondino, F., & Visintini, D. (2012). Photogrammetry and laser scanning for archaeological site 3D modeling—Some critical issues. Paper presented at the *Proc. of the 2nd Workshop on'the New Technologies for Aquileia'*, V. Roberto, L. Fozzati,
- Bennett, T. (1995). *The Birth of the Museum : History, theory, politics*. Routledge.

Berthon, P., Pitt, L., Kietzmann, J., & McCarthy, I. P. (2015). CGIP: Managing consumer-generated intellectual property. *California Management Review*, 57(4), 43-62.

Black, G. (2012). *The engaging museum: Developing museums for visitor involvement* Routledge.

Blackbox-av. Retrieved from <https://www.blackboxav.co.uk/>

Bogle, E. (2013). *Museum exhibition planning and design*: AltaMira Press.

Bowen, J. P., & Filippini-Fantoni, S. (2004). Personalization and the web from a museum perspective. Paper presented at the *Museums and the Web*, ,4

Bowen, J., Bradburne, J., Burch, A., Dierking, L., Falk, J., Fantoni, S.F., Gammon, B., Giusti, E., Gottlieb, H., Hsi, S. and Lonsdal . (2008). *Digital technologies and the museum experience: Handheld guides and other media* Rowman Altamira.

Braden, C. (2016). Welcoming all visitors: Museums, accessibility, and visitors with disabilities. *Ann Arbor, 1001*, 48109-41354.

Brightsign. (NA). 9/11 Memorial & Museum. Retrieved from <https://www.brightsign.biz/customers/museums/911-memorial-museum>

British Council and IMA, & Sarah Boiling i. (2016). *Audience development toolkit*. Retrieved from <https://www.britishcouncil.org/sites/default/files/ima-audience-development-toolkit.pdf>

British Museum. (2017). General history. Retrieved from

https://www.britishmuseum.org/about_us/the_museums_story/general_history.aspx

Brousseau, G., & Balacheff, N. (1998). *Théorie des situations didactiques: Didactique des mathématiques 1970-1990*. La pensée sauvage Grenoble.

Brown, A. L. (1994). The Advancement of Learning. *Educational Researcher*, 23(8), 4-12.

Brown, M. K., Valliath, G. T., & Nash, D. R. (2013). Interactive projection with gesture recognition. *Interactive Projection with Gesture Recognition*.

Brown, T. (2008). Design Thinking. *Harvard Business Review*, 86(6), 84.

Buchanan, M. T. (2019). *Global perspectives on catholic religious education in schools: Volume* Springer.

Burnett, A., Sloan, K., & Museum British. (2003). *Enlightenment: Discovering the world in the eighteenth century*. British Museum Press.

Carbonell, B. M. (2004). *Museum studies: An anthology of contexts*. Blackwell.

CDC. (2019). Data and statistics on autism spectrum disorder | CDC. Retrieved from

<https://www.cdc.gov/ncbddd/autism/data.html>

Chadwick, J. C. (1998). *A survey of characteristics and patterns of behavior in visitors to a museum web site*. The University of New Mexico.

- Chen, J. (2018). The ultimate social media for museums guide. Retrieved from <https://sproutsocial.com/insights/social-media-for-museums/>
- Cherry, J. F., & Walker, S. (1996). *Delight in diversity: Display at the British museum: Seminar, March 1995*. British Museum.
- Ciolfi, L., & Bannon, L. (2002). Designing interactive museum exhibits: Enhancing visitor curiosity through augmented artefacts. Paper presented at the *Eleventh European Conference on Cognitive Ergonomics, 7*.
- Clancey, W. J. (2016). *Creative Engineering: Promoting Innovation by Thinking Differently*, by John E. Arnold. Edited with an Introduction and Biographical Essay by William J. Clancey.
- Cock, M., Brenton, M., Fineman, A., France, R., Madge, C., & Sharpe, M. (2018). *State of museum access (2018)*. Retrieved from <file:///Users/TonyMacBook/Downloads/State-of-Museum-Access-2018.pdf>
- Commuri, S., & Gentry, J. W. (2000). Opportunities for family research in marketing. University of Nebraska - Lincoln
- Connolly, T. (2011). *Leading issues in games-based learning research*. Reading, England: Academic Publishing International.
- Consalvo, M. (2003). *It's a queer world after all: Studying the sims and sexuality*. Glaad.
- Corcoran, F., Demaine, J., Picard, M., Dicaire, L., & Taylor, J. (2002). Inuit3d: An interactive virtual 3d web exhibition. Paper presented at the *Museums and the Web*, 18-20.

Cornford, F. M. (2013). *Plato's theory of knowledge*. Routledge.

COST. (2019). COST | European cooperation in science and technology. Retrieved from <https://www.cost.eu/>

Craig, A. B. (2013). *Understanding augmented reality: Concepts and applications*. Newnes.

Cribb, J. The HSBC Money Gallery at the British Museum: access to excellence. In *I Congreso Internacional de Museología del Dinero, Madrid-España 18-22 Octubre 1999* (pp. 197-207).

Csapodi, C. (1969). *Bibliotheca Corviniana: The library of King Matthias Corvinus of Hungary*. Praeger.

Damala, A. (2009). *Interaction Design and Evaluation of Mobile Guides for the Museum Visit: A Case Study in Multimedia and Mobile Augmented Reality* (Doctoral dissertation).

Dean, D. (2002). *Museum exhibition: Theory and practice*. Routledge.

Debono, S. (2019, -03-30T12:15:53.078Z). *Me ... the Neo-Humanist?*, Medium
Retrieved from <https://medium.com/the-neo-humanist-museum/me-the-neo-humanist-484e9e89e35>

Di Franco, Paola Di Giuseppantonio, Camporesi, C., Galeazzi, F., & Kallmann, M. (2015). 3D printing and immersive visualization for improved perception of ancient artifacts. *Presence: Teleoperators and Virtual Environments*, 24(3), 243-264.

- Dierking, L. D., & Falk, J. (2000a). *Learning from Museums: Visitor experiences and the making of meaning*. AltaMira Press Walnut Creek, CA.
- Dierking, L. D., & Falk, J. (2000b). *Learning from museums: Visitor experiences and the making of meaning* AltaMira. Press Walnut Creek, CA.
- Dilenschneider, C. (2019). Perceptions matter – how welcoming are cultural organizations? (DATA). Retrieved from <https://www.colleendilen.com/2019/03/20/perceptions-matter-how-welcoming-are-cultural-organizations-data/>
- Dodd, J., Jones, C., Sawyer, A., & Tseliou, M. (2012). Voices from the museum: Qualitative research conducted in Europe's national museums.
- Döpker, A., Brockmann, T., & Stieglitz, S. (2013). Use cases for gamification in virtual museums. *INFORMATIK 2013–Informatik Angepasst an Mensch, Organisation Und Umwelt*.
- Douma, M., & Henchman, M. (2000). Bringing the object to the viewer: Multimedia techniques for the scientific study of art. *Museums and the Web 2000*, , 59-64.
- Doering, Z.D. (1999). Strangers, guests or clients? Visitor Experiences in Museums. *The Museum Journal* 42, no.2 (1999): 74-87
- Drotner, K., & Schröder, K. C. (2014). *Museum communication and social media: The connected museum*. Routledge.

- Dudley, S. H. (2013). Museum Materialities: Objects, sense and feeling. *Museum materialities* (pp. 21-38). Routledge.
- Economou, M., & Meintani, E. (2011). *Promising beginning? evaluating museum mobile phone apps*. University of Glasgow
- Eagleton, C. (2007). In Williams J., Cribb J. and Errington E. (Eds.), *Money: A history* (2nd ed.. ed.) British Museum.
- Edwards, E. (1870). *Lives of the founders of the British Museum* (Vol). Trübner and Company.
- European Structural & Investment Funds. (2019). Yes! The EU supports cultural heritage. Retrieved from <https://cohesiondata.ec.europa.eu/stories/s/Yes-The-EU-supports-cultural-heritage/9gyi-w56p/>
- Falk, J (1998). Visitors-who does, who doesn't, and why (why people go to museums). *Museum News*, 77(2), 38-43.
- Falk, J. (1999). Museums as institutions for personal learning. *Daedalus*, 128(3), 259-275.
- Falk, J. H. (2000). In Dierking L. D., American Association for State and Local History (Eds.), *Learning from museums: Visitor experiences and the making of meaning*. Altamira P.
- Falk, Howard & Dierking, L. D. (2002). *Lessons without limit: How free-choice learning is transforming education*. Rowman Altamira.
- Falk, J. (2004). The director's cut: Toward an improved understanding of learning from museums. *Science Education*, 88(S1), S83-S96.

- Falk, J. H. (2005). Free choice environmental learning: framing the discussion. *Environmental education research*, 11(3), 265-280.
- Falk, J. (2006). The impact of visit motivation on learning: Using identity as a construct to understand the visitor experience. *Curator*, 49(2), 151-166.
- Falk, J. (2016). Museum audiences: A visitor-centred perspective. *Loisir Et Société / Society and Leisure*, 39(3), 357-370. doi:10.1080/07053436.2016.1243830
- Falk, Howard. (2016). *Identity and the museum visitor experience*. Routledge.
- Falk, Howard & Dierking, L. D. (2016). *The museum experience*. Routledge.
- Filippini-Fantoni, S., McDaid, S., & Cock, M. (2011). Mobile devices for orientation and way finding: The case of the British museum multimedia guide. *Museums and the Web 2011: Proceedings, Toronto: Archives & Museum Informatics (En Línea)*.
[Http://Www.Museumsandtheweb.Com/mw2011/Papers/Mobile_devices_for_orientation_and_way_finding.html](http://www.museumsandtheweb.com/mw2011/Papers/Mobile_devices_for_orientation_and_way_finding.html), Acceso, 25.
- Findlen, P. (1989). The museum: Its classical etymology and renaissance genealogy. *Journal of the History of Collections*, 1(1), 59-78.
- Fleck, M., Frid, M., Kindberg, T., O'Brien-Strain, E., Rajani, R., & Spasojevic, M. (2002). From informing to remembering: Ubiquitous systems in interactive museums. *IEEE Pervasive Computing*, 1(2), 13-21.

- Flowers, A. (2018). Taking sculptures for a walk: 3D printing and museum outreach • V&A blog. Retrieved from <https://www.vam.ac.uk/blog/digital/taking-sculptures-for-a-walk-3d-printing-and-museum-outreach>
- Fritsch, J. (2011). *Museum gallery interpretation and material culture*. Routledge.
- Fund, H.L. (2010) Thinking about....Audience development. Retrieved from https://www.culturehive.co.uk/wp-content/uploads/2013/04/HLF-Thinking_about_audience_development.pdf
- Gauci, M. (2018). *The cathedral museum of Mdina. A monumental complex of Maltese baroque splendour*. Malta: BDL.
- Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment (CIE)*, 1(1), 20.
- Gellel, A. (2018). Towards a symbol literacy approach in the education of children. *International Journal of Children's Spirituality*, 23(2), 109-121. doi:10.1080/1364436X.2018.1448761
- Geller, T. (2006). Interactive tabletop exhibits in museums and galleries. *IEEE Computer Graphics and Applications*, 26(5), 6-11.
- Gilman, B. I. (1918). *Museum ideals of purpose and method*. Boston: Order of the Trustees of the Museum of Fine Arts Boston - Riverside Press.

- Gold, R. L. (1958). Roles in sociological field observation, in “social forces”, XXXVI. *GJ McCall & JL Simmons (1969) Issues in Participant Observation. Boston: Addison–Wesley Publishing Company.*
- Goldman, K. H., Schaller, D. T., & Adventures, E. W. (2004a). Exploring motivational factors and visitor satisfaction in on-line museum visits. Paper presented at the *In D. Bearman & J. Trant (Eds.), Museums and the Web 2004.*
- Goldman, K. H., Schaller, D. T., & Adventures, E. W. (2004b). Exploring motivational factors and visitor satisfaction in on-line museum visits. Paper presented at the *In D. Bearman & J. Trant (Eds.), Museums and the Web 2004.*
- GOSH arts. (NA). Retrieved from <https://www.gosh.nhs.uk/wards-and-departments/departments/gosh-arts>
- Graves, R. (2017). *The Greek myths: The complete and definitive edition.* Penguin UK.
- Gaxho, D., Skene, W., Skorinko, N., & White, K. (2009). *Evaluating the galleries of the department of coins and medals at the British museum..* United Kingdom:
- Grossman, G. M., & Helpman, E. (1991). *Innovation and growth in the global economy.* MIT press.
- Guggenheim. (2018, -01-26T20:04:20+00:00). Solomon R. Guggenheim museum public social media community guidelines. Retrieved from <https://www.guggenheim.org/social/social-media-guidelines>

Guidi, G., Barsanti, S. G., Micoli, L. L., & Russo, M. (2015). Massive 3D digitization of museum contents. *Built heritage: Monitoring conservation management* (pp. 335-346). Springer.

Gurney, A. (2019). The complete guide to UGC for museums. Retrieved from <https://cdn2.hubspot.net/hubfs/2719325/eBooks/The%20Complete%20Guide%20to%20UGC%20for%20Museums%20eBook.pdf>

Gutwill, J. P. (2002). Gaining visitor consent for research: Testing the posted-sign method. *Curator: The Museum Journal*, 45(3), 232-238.

Hamma, K. (2004). The role of museums in online teaching, learning, and research. *First Monday*, 9(5).

Hancock, M. (2015). Museums and 3D printing: More than a workshop novelty, connecting to collections and the classroom. *Bulletin of the Association for Information Science and Technology*, 42(1), 32-35. doi:10.1002/bul2.2015.1720420110.

Hargrave, J., & Mistry, R. (2013). Museums in the digital age. *Arup, London*.

Harrison, J. D. (1994). Ideas of museums in the 1990s. *Museum Management and Curatorship*, 13(2), 160-176.

Hartlaub, P. (). Our SF: King Tut ruled San Francisco in 1979. *SFGate* Retrieved from <https://www.sfgate.com/oursf/article/Our-SF-King-Tut-ruled-San-Francisco-in-1979-6431995.php#photo-8433639>

- Hawkey, R. (2004). Learning with digital technologies in museums, science centres and galleries. HAL.
- Hein, G. E. (1999). The constructivist museum. *The Educational Role of the Museum*, 2, 73-79.
- Hein, G. E. (1993). The significance of constructivism for museum education. *Museums and the Needs of the People, Jerusalem. Israel ICOM Committee*.
- Hein, G. E. (2002). *Learning in the museum*. Routledge.
- Henley, D. (2012). *Cultural education in England; an independent review by Darren Henley for the department for culture, media and sport and the department for education*. UK:
Retrieved from
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/260726/Cultural_Education_report.pdf
- Herman, D. L., Johnson, K., & Ockuly, J. (2004). What clicked? an interim report on audience research and media resources. *Museums and the Web 2004.Ed.*
- Hood, M. G. (1983). Staying away: Why people choose not to visit museums. *Museum News*, 61(4), 50-57.
- Hood, M. G. (1991). Significant issues in museum audience research. Paper presented at the *Visitor Studies: Theory, Research and Practice: Proceedings of the 199 J Visitor Studies Conference. Jacksonville, AL: Center for Social Design*, 18-23.

Hooper-Greenhill, E. (2007). *Museums and education: Purpose, pedagogy, performance*.
Routledge.

Hooper-Greenhill, E. (2013). *Museums and their visitors*. Routledge.

Hooper-Greenhill, E., Dodd, J., Moussouri, T., Jones, C., Pickford, C., Herman, C., Morrison,
M., Vincent, J. & Toon, R. (2003). Measuring the outcomes and impact of learning in
museums, archives and libraries: The learning impact research project end of project paper.

Hudson, K. (1977a). *Museums for the 1980's* London: Macmillan, Sept. 1977.

Hudson, K. (1977b). *Museums for the 1980s : A survey of world trends* UNESCO (1977).

Illich, I., & Lang, A. (1973). Tools for conviviality.

Jam creative studios. (n.d.) Retrieved from <http://jamcreativestudios.com/>

KEA European Affairs. (2006). *The economy of culture in Europe: A study prepared for the
european commission (directorate-general for education and culture)* EC.

Keen, A. (2007). *The cult of the amateur: How today's internet is killing our culture*. Doubleday.

Kelley, T., & Kelley, D. (2013). *Creative confidence: Unleashing the creative potential within us
all*. Currency.

Kent, M. L., & Taylor, M. (1998). Building dialogic relationships through the world wide web.
Public Relations Review, 24(3), 321-334.

- Knell, S. J. (2003). The shape of things to come: Museums in the technological landscape. *Museum and Society*, 1(3), 132-146.
- Knowles, M. S., Holton III, E. F., & Swanson, R. A. (2012). *The adult learner*. Routledge.
- Kravchyna, V., & Hastings, S. K. (2002). Informational value of museum web sites. *First Monday*, 7(2)
- Krumm, J., Davies, N., & Narayanaswami, C. (2008). User-generated content. *IEEE Pervasive Computing*, 7(4), 10-11.
- Kurth, W. (1963). *The complete woodcuts of Albrecht Dürer*. Courier Corporation.
- Lang, C., Reeve, J., & Woollard, V. (2006). *The responsive museum: Working with audiences in the twenty-first century*, Ashgate Publishing, Ltd.
- Lee, J. C., Hudson, S. E., Summet, J. W., & Dietz, P. H. (2005). Moveable interactive projected displays using projector based tracking. Paper presented at the *Proceedings of the 18th Annual ACM Symposium on User Interface Software and Technology*, 63-72.
- Lee, P. Y. (1997). The musaeum of alexandria and the formation of the muséum in eighteenth-century france. *The Art Bulletin*, 79(3), 385-412. doi:10.1080/00043079.1997.10786791
- Lisney, E., Bowen, J. P., Hearn, K., & Zedda, M. (2013). Museums and technology: Being inclusive helps accessibility for all. *Curator: The Museum Journal*, 56(3), 353-361.
- Liu, K. (2013). Designing visitor experiences for open-ended creative engagement in art museums: A conceptual multi-touch prototype design. Iowa State University.

- Loomis, R. J. (1987). *Museum visitor evaluation: New tool for management*. Nashville TN: American Association for State and Local History (1987).
- MacDonald, G. F., & Alford, S. (1991). The museum as information utility. *Museum Management and Curatorship*, 10(3), 305-311.
- Macdonald, S. (2006). *A companion to museum studies*. Blackwell.
- Macdonald, S. (2007). Interconnecting: Museum visiting and exhibition design. *CoDesign*, 3(S1), 149-162.
- MacLeod, S., Dodd, J., & Duncan, T. (2015). New museum design cultures: Harnessing the potential of design and 'design thinking' in museums. *Museum Management and Curatorship*, 30(4), 314-341.
- MacGregor, A. (2001). *The Ashmolean museum: A brief history of the museum and its collections*. Ashmolean Museum.
- Mairesse, F., & Desvallées, A. (2010). Key concepts of museology, international council of museums. *Paris: Armand Colin*.
- Marty, P. F. (2007). Museum websites and museum visitors: Before and after the museum visit. *Museum Management and Curatorship*, 22(4), 337-360.
- Marwick, A. (1990). *British society since 1945*
- Massinelli, A. M., Tuena, F. M., & dagli Orti, G. (1992). *Treasures of the medici*. Thames and Hudson.

- Mccall, V., & Gray, C. (2014). Museums and the 'new museology': Theory, practice and organisational change. *Museum Management and Curatorship*, 29(1), 19-35.
doi:10.1080/09647775.2013.869852
- McClellan, A. (1994). *Inventing the louvre: Art, politics, and the origins of the modern museum in eighteenth-century Paris*. University of California Press.
- McGonigal, J. (2011). *Reality is broken: Why games make us better and how they can change the world*. Penguin.
- McLean, K., & Pollock, W. (2010). *The convivial museum*. Association of Science-Technology Centers Incorporated.
- Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE Transactions on Information and Systems*, 77(12), 1321-1329.
- Moussouri, T. (1997). *Family agendas and family learning in hand-on museums*
- Moussouri, T. (2002). A context for the development of learning outcomes in museums, libraries and archives.
- Murray, D. (1904). *Museums, their history and their use*. London: Routledge/Thoemmes Press.
- Murray, S. A. (2009). *The library: An illustrated history*. Skyhorse Publishing, Inc.
- Museum ExplorAR: Immersive augmented reality experience at national museum cardiff. – MW19 | boston. (). Retrieved from <https://mw19.mwconf.org/glami/museum-explorar-immersive-augmented-reality-experience-at-national-museum-cardiff/>

Museum, C. (2017). The Dürer collection – mdina cathedral museum archives. Retrieved from <https://www.metropolitanchapter.com/mdina-cathedral-museum/discover-the-museum/the-durer-collection/>

NEMO. (2019). Audience development.

Retrieved from <https://culture360.asef.org/resources/network-european-museum-associations-nemo/>

Nesamalar, E. K., & Ganesan, G. (2012). An introduction to virtual reality techniques and its application. *International Journal of Computing Algorithm*, 1(02).

Neumüller, M., Reichinger, A., Rist, F., & Kern, C. (2014). 3D printing for cultural heritage: Preservation, accessibility, research and education. *3D research challenges in cultural heritage* (pp. 119-134). Springer.

Nicholson, S. (2015). A recipe for meaningful gamification. *Gamification in education and business* (pp. 1-20). Springer.

O'Connor, P. (2008). User-generated content and travel: A case study on tripadvisor. com. *Information and Communication Technologies in Tourism 2008*, 47-58.

Orna-Ornstein, J. (1997). *The story of money*. British Museum Press.

Orna-Ornstein, J. (2001). *Development and evaluation of the HSBC money gallery at the British Museum*. British Museum.

Othman, M. K., Petrie, H., & Power, C. (2011). Engaging visitors in museums with technology: Scales for the measurement of visitor and multimedia guide experience. Paper presented at the *IFIP Conference on Human-Computer Interaction*, 92-99.

Ovenell, R. F. (1986). *The Ashmolean Museum 1683-1894*. Oxford University Press, USA.

Packer, J., & Ballantyne, R. (2002). Motivational factors and the visitor experience: A comparison of three sites. *Curator: The Museum Journal*, 45(3), 183-198.

Pagel, J. (2008). Digitisation in european museums. *NEMO Newsletter*, (1) Retrieved from https://www.ne-mo.org/fileadmin/Dateien/public/NEMONews/NEMOnews2008_1.pdf

Paisley, W. J. (1968). The museum computer and the analysis of artistic content. *Computers and their Potential Applications in Museums*, , 195-216.

Pamuk, O. (2010). *The museum of innocence*. Knopf Canada.

Pamuk, O. (2013). A modest manifesto for museums.

Retrieved from <https://Craftcouncil.Org/Magazine/Article/Modest-Manifesto-Museums> (2016-06-19),

Parry, R. (2013). The end of the beginning: Normativity in the post digital museum. *Museum Worlds*, 1(1), 24-39.

Pekarik, A. J. (2011). The long horizon: The shared value of museums. *Curator: The Museum Journal*, 54(1), 75-78.

- Pekarik, A. J., Doering, Z. D., & Karns, D. A. (1999). Exploring satisfying experiences in museums. *Curator: The Museum Journal*, 42(2), 152-173.
- Pierroux, P., Bannon, L., Walker, K., Hall, T., Kaptelinin, V., & Stuedahl, D. (2007). MUSTEL: Framing the design of technology-enhanced learning activities for museum visitors.
- Plattner, H., Meinel, C., & Leifer, L. (2012a). *Design thinking research*. Springer.
- Powell, L. (2015). *Marcus Agrippa: Right-hand man of Caesar Augustus*. Pen and Sword.
- Princeton University. (2004). Shang Zhou dynasty ca. 1600–256 B.C.
Retrieved from <https://goo.gl/Jof8wf>
- Proctor, N., & Tellis, C. (2003). The state of the art in museum handhelds in 2003.
- Pryor, H. L., Furness III, T. A., & Viirre III, E. (1998). The virtual retinal display: A new display technology using scanned laser light. Paper presented at the *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 42(22) 1570-1574.
- Queirós, A., Faria, D., & Almeida, F. (2017). Strengths and limitations of qualitative and quantitative research methods. *European Journal of Education Studies*.
- Rand, J. (2004). The visitors' bill of rights. *Reinventing the Museum: Historical and Contemporary Perspectives on the Paradigm Shift*, 158-159.
- Raskar, R., Welch, G., & Chen, W. (1999). Table-top spatially-augmented reality: Bringing physical models to life with projected imagery. Paper presented at the *Proceedings 2nd IEEE and ACM International Workshop on Augmented Reality (IWAR'99)*, 64-71.

RCMG. (2018). About us — University of Leicester. Retrieved from

<https://www2.le.ac.uk/departments/museumstudies/rcmg/about-us>

Ripley, S. D. (1978). *The sacred grove: Essays on museums*. Smithsonian Inst Pr.

Roberts, L. C. (2014). *From knowledge to narrative: Educators and the changing museum*.

Smithsonian Institution.

Rocchini, C., Cignoni, P., Montani, C., Pingi, P., Scopigno, R., Fontana, R., Greco, M.,

Pampaloni, E., Pezzati, L., Cygielman, M. & Giachetti, R (2001). 3D scanning the minerva of arezzo. Paper presented at the *Ichim (2)*, 266-272.

Ross, M. (2004). Interpreting the new museology. *Museum and Society*, 2(2), 84-103.

Sauro, J. (2015). MeasuringU: 4 types of observational research. Retrieved from

<https://measuringu.com/observation-role/>

Scott, C. (2018, -08-14T21:09:09+00:00). Museum ExplorAR: Augmented reality at national

museum cardiff. Retrieved from <http://cardiffmummiesays.com/cardiff/museum-explorar-augmented-reality-at-national-museum-cardiff/>

Shaw, M. (1995). Highways for learning: An introduction to the internet for schools and

colleges. *Coventry: National Council for Educational Technology*.

Sherwin, A. (2015, Jan). Museum risks Greek anger with talk of more Elgin marbles loans.

Silverman, D. (2006). *Interpreting qualitative data: Methods for analyzing talk, text and interaction*. Sage.

- Simon, N. (2010). *The participatory museum*. Museum 2.0.
- Smith, J. K., & Smith, L. F. (2001). Spending time on art. *Empirical Studies of the Arts*, 19(2), 229-236.
- Sparacino, F. (2002). The museum wearable: Real-time sensor-driven understanding of visitors' interests for personalized visually-augmented museum experiences.
- Stam, D. C. (1993). The informed muse: The implications of 'the new museology' for museum practice. *Museum Management and Curatorship*, 12(3), 267-283.
- Stand, J. (2000). The "hawthorne effect"-what did the original hawthorne studies actually show. *Scand J Work Environ Health*, 26(4), 363-367.
- Stenson, B. (2018, July). Paris's first digital art museum: All lit up at atelier des lumières. *The Guardian*. Retrieved From: <https://www.theguardian.com/travel/2018/jul/26/atelier-des-lumiere-paris-digital-art-museum-klimt>
- Sterry, P., & Beaumont, E. (2006). Methods for studying family visitors in art museums: A cross-disciplinary review of current research. *Museum Management and Curatorship*, 21(3), 222-239.
- Stoddart, P., & Sugden, K. The decline of the specialist numismatic curator (and numismatics?): The UK experience ICOMON e-proceedings (Utrecht, 2008).
- Styliani, S., Fotis, L., Kostas, K., & Petros, P. (2009). Virtual museums, a survey and some issues for consideration. *Journal of Cultural Heritage*, 10(4), 520-528.

Tallon, L., & Walker, K. (2008). *Digital technologies and the museum experience: Handheld guides and other media*. AltaMira Press.

Taxén, G. (2005). Participatory design in museums. *Participatory Design in Museums: Visitor-Oriented Perspectives on Exhibition Design*.

Taylor, J., & Gibson, L. K. (2017). Digitisation, digital interaction and social media: Embedded barriers to democratic heritage. *International Journal of Heritage Studies*, 23(5), 408-420.

Teslasuit | full body haptic VR suit for motion capture and training. Retrieved from <https://teslasuit.io/>

The Propylaia. (n.d.). The propylaia. Retrieved from <https://www.theacropolismuseum.gr/en/content/propylaia>

Thomas, S., & Mintz, A. (1998). *Virtual and the real: Media in the museum*. American Association of Museums.

Tilden, F. (1977). *Interpreting our heritage* (3rd ed.) University of South Carolina P.

Touching the Prado - exhibition. Retrieved from <https://www.museodelprado.es/en/whats-on/exhibition/touching-the-prado/0d94a9bf-07d7-491a-866a-37976169f929>

Undeen, D. (2103). 3D scanning, hacking, and printing in art museums, for the masses. Retrieved from <https://www.metmuseum.org/blogs/digital-underground/posts/2013/3d-printing>

- University of Malta International Institute for, Baroque Studies. (2013). In University of Malta. International Institute for Baroque Studies (Ed.), *Baroque routes newsletter - issue 9*
University of Malta. International Institute for Baroque Studies.
- Van Mensch, P. (1992). Towards a methodology of museology. *PhD Diss., University of Zagreb, Croatia.*
- Vauillaume, D. (2015). Revisiting the educational value of museums connecting to audiences. Paper presented at the *NEMO 23rd Annual Conference*, 8.
- Velarde, G. (2017). *Designing exhibitions: Museums, heritage, trade and world fairs* Routledge.
- Vella, E. (2017). The Durer collection | Mdina cathedral museum archives. Retrieved from <https://www.metropolitanchapter.com/mdina-cathedral-museum/discover-the-museum/the-durer-collection/>
- Vergo, P. (1989). *The new museology*. Reaktion Books.
- Vicente, E., Camarero, C., & Garrido, M. J. (2012). Insights into innovation in european museums: The impact of cultural policy and museum characteristics. *Public Management Review*, 14(5), 649-679.
- Vistica, O., & Grubisic, D. (2017). *The museum of broken relationships: Modern love in 203 everyday objects*. Hachette UK.
- Vital, R. (2017). [Http://Td1406.csites.fct.unl.pt/wordpress/](http://td1406.csites.fct.unl.pt/wordpress/). Retrieved from <http://td1406.csites.fct.unl.pt/wordpress/>

- Vlahakis, V., Pliakas, T., Demiris, A. M., & Ioannidis, N. (2003). Design and application of an augmented reality system for continuous, context-sensitive guided tours of indoor and outdoor cultural sites and museums. Paper presented at the *Vast*, 155-164.
- Vom Lehn, D., Heath, C., & Hindmarsh, J. (2002). Video based field studies in museums and galleries. *Visitor Studies Today*, 5(3), 15-23.
- Von Thienen, J. P., Clancey, W. J., Corazza, G. E., & Meinel, C. (2018). Theoretical foundations of design thinking. *Design thinking research* (pp. 13-40). Springer.
- Vu, H. Q., Luo, J. M., Ye, B. H., Li, G., & Law, R. (2018). Evaluating museum visitor experiences based on user-generated travel photos. *Journal of Travel & Tourism Marketing*, 35(4), 493-506. doi:10.1080/10548408.2017.1363684
- Walker, R. (2015). *Museums - where we invite the muses in*. Boston, Massachusetts.
- Walsh, K. (2002). *The representation of the past: Museums and heritage in the post-modern world*. Routledge.
- Waltl, C. (2006). Museums for visitors: Audience development-A crucial role for successful museum management strategies. *Intercom, 2006*, 1-7.
- Weiss, R. (1969). *The renaissance discovery of classical antiquity*. Blackwell.
- Welcome to europeana collections. Retrieved from
<https://www.europeana.eu/portal/en/about.html>

Wenger, E. (1999). *Communities of practice: Learning, meaning, and identity*. Cambridge university press.

Wiese, E. (1960). Experiences with short wave radio tours in the hesse museum at darmstadt, in museumskunde. *Unpublished Letter by Der Deutsche Museumbund, Verlag Walter De Gruyter & Co., Berlin, 1961*

Williams, D. J., Cribb, J., & Errington, E. (1997). *Money: A history* St. Martin's Press.

Woolley, L. (2009). *Excavations at Ur: A record of twelve years' work*. Routledge.

Appendix

APP2.2 Museum Audiences

APP2.2a Audience Groupings Toledo Museum of Art

Frequent visitors (14%) visit museums various times during the year. These visitors' value all the 6 leisure attributes and feel that they are all satisfied by visits to museums. An opportunity for learning, the challenge of new experiences and spending leisure time in a worthwhile manner are the 3 attributes to which they give highest importance. These account for 40% - 50% of all museum visitors and fit the typical museum visitor profile.

Nonparticipants are the highest segment - 46% of the public. For this segment, the highest 3 leisure attributes were the 3 that frequent visitors considered least important, being socializing, active participation and feeling at ease in their surroundings. Generally speaking, nonparticipants did not often frequent museums as children. As adults they choose leisure venues other than museums that offer them socialization and active participation in casual and familiar surroundings. Nonparticipants feel that these leisure attributes are not sufficiently present in museums. For them museums are formal inaccessible places, venues which restrict active participation and limit group social behavior. For this category of people, shopping malls, picnics and sporting environments offer much more in terms of leisure benefits.

Occasional Participants are those who visit museums once or twice a year. These visitors account for 40% of the sample interviewed. Interestingly these visitors are completely different from the frequent visitors in their leisure values and socialization requirements. Their profile is in fact closer to that of nonparticipants. As children, occasional participants took part in activities that accentuated active participation. As adults they also participate in various outdoor activities.

Both occasional participants and nonparticipants put a strong emphasis on family-centred activities. Occasional participants do not feel that they belong in museums. They feel that, although some of the leisure attributes can be met within museums, these are not strong enough to merit regular visits to the museum and they would often choose other competing venues or activities where to spend their family days and outings.

APP2.2b Maslow's hierarchy of needs applied for museums

Physiological needs – These cover the visitor's most basic needs and include services such as restrooms, cafes and catering facilities, areas where the visitor can have a break and rest, a comfortable climate within the museum, acceptable noise levels both with regard to interactive exhibits but also related to the number of visitors, as well as accessibility to people with particular needs.

Safety needs – These are not only the obvious safety precautions, such as fire exits and conformity with health and safety regulations, but should also include, pre-visit planning information to help the visitor feel safe – this is especially important in the case of visitors with disabilities. Visitors need to feel at ease when visiting the museum and this includes having a clear sense of orientation, knowing where they are, and being aware of access to exits, toilets and emergency assistance.

Love and belonging – Visitors to museums should feel welcome, know where to go, what to expect and what is expected of them. The quality of the museum staff, signage and colour schemes help make the visitor welcome. Correct presentation of information and artefacts can also make the visitor feel welcome rather than completely lost or intimidated. When attending a museum, visitors must be able to understand what is unique about the museum they are visiting and how it is relevant to them. The museum must also make sure that visitors with special needs feel welcome by ensuring accessibility

Self-esteem – museums should recognize the visitor's worth and respect as an individual. This can be shown in the museum's authenticity and integrity as displayed in the accuracy of information provided. This involves offering a professional service in every aspect including staff, communication, support services and quality of exhibits to name a few examples. Offering

different levels of information will help different types of audiences understand what is on display, irrespective of whether they are professionals, one off visitors or children.

Self-actualization – Once their basic needs are met, people should have the chance to improve themselves by achieving their full potential. Whilst even Maslow recognizes this goal can never be reached completely, it helps museums realize that providing for visitor personal growth is a very important human right for visitors.

APP2.2c Falk's Visitor Categorization

Explorers – This category of visitors is primarily motivated by personal curiosity and interest. Although not experts, these visitors value learning. Rare items on display or new exhibits are placed high up on their interest list as they seek to explain their interests. Explorers account for a large segment of museum visitors; they do not look for a structured visit and tend to shy away from interpretative tools and guided tools.

Facilitators – these visitors wish to satisfy not only their own needs and desires but also the needs of someone they love. Time and price consciousness are common characteristics of such visitors. Facilitators can be further grouped into two subgroups.

- **Facilitating Parents** are visitors taking care of their own children or grandchildren. Whilst they believe that museum learning can be fun, their main motivator for visiting museums is to reinforce their identity need to be perceived as good parents by their children, others and even themselves.
- **Facilitating socializers** are those visitors who are accompanied by another adult member be it spouse, partner, visiting friend or relative. Visiting the museum is more of a social outing, a way to spend time together with minimal attention to the artefacts on exhibit.

Experience Seekers - are motivated by a need to feel that they've "been there" and "seen or done it". Very often tourists are experience seekers and are looking at visiting important sites or museums as part of their holiday. The topic is not the main motivator for the visit, the desire to have fun with friends or family is what motivates them to the rare museum visit. Except for the main landmark museums, experience seekers do not visit many museums. It is interesting to note that most people in this category of visitor would not have visited museums as children and, even as adults, would rarely visit any.

Professionals / Hobbyists - This is the smallest category of visitors, yet they are also very influential. This category includes people such as fine art or antique collectors, educators and museum professionals. When visiting the museum, they would have a very clearly identified goal. It is highly unlikely that they are part of a group, though they might be part of a small niche audience.

Rechargers – Visitors in this category look at museums as a safe haven away from it all, a place where they can go to recharge themselves. Art museums, aquariums and botanical gardens usually attract a lot of rechargers. Individual artefacts are not the primary interest of such visitors and exhibits are often considered part of the overall general scenery.

APP2.3 Museum Learning

APP2.3.1 Learning Impact Research Project (LIRP)

Professor Eilean Hooper-Greenhill (2007) set up the Research Centre of Museums and Galleries together with the School of Museum Studies of the University of Leicester in 1999. Its primary purpose is to carry out research that will contribute and influence museum policy and development on an international level. As part of a broader research project entitled “Inspiring Learning for all”, the project *Learning Impact Research Project (LIRP)* developed a framework of five Generic Learning Outcomes (GLOs). This framework was tested and implemented on 15 museums, libraries and archives. The aim of this pilot project was to show that this GLO framework has potential for measuring learning throughout similar cultural institutions in the sector.

Despite the consensus that museums, libraries and archives are important places of learning, a method for measuring the actual impact such institutions had on their visitors’ learning was until then not available. Some museums feel that their primary focus should not be on the users’ learning experience. This, together with the lack of a common language to describe outcomes, makes measuring learning experiences quite difficult.

In the General Learning Outcomes framework, the emphasis is no longer on education but has shifted to learning. Education is seen as a formal process whereby society passes on knowledge and skills to its members using common standards. Learning is the informal, ongoing process of acquiring knowledge, values and skills.

The end of the project LIRP paper, entitled “Measuring the outcomes and impact of learning in Museums, Archives and Libraries”, explained that the biggest challenge was to

develop and open up the traditional and often very narrow view of learning. A broader definition of learning, focusing on learner-centred processes and their learning experiences, rather than on the traditional teacher-driven approach, was adopted.

Learning outcomes are the product of an individual's learning experience. In formal education, learning outcomes are used to measure the learner's progress following a programme of study. Learning outcomes can be classified as either specific or generic. Whereas measuring learning outcomes in formal education is relatively easy, measuring learning outcomes by museums can be much more difficult since it is impossible for them to know exactly how much progress or learning has been achieved by individual users. On the other hand, visitors themselves can give feedback on their own personal learning, assessing whether the visit provided what they were looking for or not, if it was enjoyable and/or inspiring. The Generic Learning Outcomes framework allows visitors' individual learning experiences to be grouped into five broad outcome categories. These five categories are very clearly explained in Eilean Hooper-Greenhill's book *Museums and education – Purpose, Pedagogy, Performance* (RCMG, 2018) and each category is further illustrated by comments from visitors about their experiences in museums. The five categories are classified as follows:



Figure 3.1 - The five main categories of the Generic Learning Outcomes Framework

Knowledge and Understanding objectives help the learner achieve a deeper understanding of a subject or specific topics allowing the visitor to make meaningful links across different subject areas. Here visitors learn new facts or grasp meaning, and existing information may gain a new meaning or relevance. Knowledge can be acquired in various ways such as reading, looking, listening or trying things out. Knowledge in itself will not result in understanding until the learner can apply that knowledge to his or her own experience. Knowledge and understanding can sometimes lead to the individual discovering new information about oneself

Skills – Intellectual, practical, professional – Skills can be defined as the ability to do something well. There are many different types of skills including Intellectual skills such as reading, critical thinking, evaluating different forms of evidence and facts; Key skills which include ICT, communication, numeric skills; Information Management skills relating to how information is found, managed and evaluated and Social skills that are obtained from meeting and relating with people and working as a team. These are often developed during cultural visits. Emotional skills, which involve learning to manage one’s own feelings such as anger or frustration, are the least often experienced in museums. Communication skills include such

abilities as presenting, talking, discussing and writing. Physical skills can often be found in practical workshops and include doing physical activities such as dancing, tracking or making things.

Attitudes and values – This category includes feelings and perceptions as well as opinions towards ourselves and others, and attitudes towards organizations. These are developed in both formal and informal learning environments. As new information is absorbed, new attitudes are formed, which in turn contribute to the development of values that affect the way people decide to live. Museum visits can cause shifts in attitudes and may alter the visitor's values. Very often such changes will not happen in the short term or with the learner consciously noticing them. As Hooper-Greenhil (2013) explains, attitudes to museums are often the result of poor or bad experiences and often make the visitor feel that museums do not work for them..

Enjoyment, Inspiration and Creativity – Learning activities that generate fun, amazement, surprise and pleasure to the learner create positive learning outcomes and the learner will be ready to repeat such experiences. Enjoyable learning is easier on the learner. Museums are open ended environments where visitors are in control of what to focus on learning whilst visiting. New ideas are often generated by the seemingly random browsing of displays. Creativity and inspiration are often the result of environments that offer experimentation and exploration.

Activity, behaviour and progression – These refer to what people do and/or the intention to do something - behaviour and activity - and may indicate both short-term as well as longer term learning outcomes. Such outcomes may influence a change in the way people manage different aspects of their lives, including family, work and community. Where a change has been achieved through action, one will be experiencing progression.

App 2.3.1 Case Study: Informal learning within the Mdina Cathedral Museum

“The Symbol Literacy” project (RCMG, 2018), is a project designed and implemented by Prof. Adrian-Mario Gellel from the Faculty of Education of the University of Malta and the Department of Early Childhood & Primary Education. The project, has a number of aims which include; enriching the children’s cultural capital as well as helping them understand symbols, aiding them in understanding and making sense of traditions and heritage passed on by previous generations, helping develop higher order thinking skills, helping children observe and understand metaphors, raising the children’s moral values, allowing children to understand reality through an interdisciplinary informal education approach and to equip them with skills and tools that will allow them to be more creative and innovative persons.

Since the beginning, symbols have been used by humans to formulate and illustrate meaning. Although all around us symbols abound in many different forms such as visual art, mythology, religion, music, just to mention a few, children are simply not aware of them. An education into Symbolic Literacy allows young children to acquire skills in analysis, evaluation, appropriation and reconstruction of symbols when used in different settings and contexts. This will, in turn, allow them to use the meanings behind these symbols in relation to themselves and the society around them.

A study entitled “an economy of Culture” prepared for the European commission, states; “education to the arts provides students with essential skills that are transferable in other areas and that will be of growing importance in the knowledge economy. These include openness to a variety of styles and cultures, team work, concentration and imagination” (Gellel, 2018). Eight

different artistic works were identified for this project, a number of which were from the Mdina Cathedral Museum.

Through prior preparation in the classroom and use of role play, props, storytelling and treasure hunts at the museum, paintings came to life, making it easier for students to understand symbols embedded in the paintings. Other activities included a listening exercise, group work and discussion groups which allowed students to reflect on the relevance of the symbols in their own lives.



Illustration 3.2.1 - photos of school children participating in “The Symbol Literacy” project held at the Mdina Cathedral Museum

Source: Symbol Literacy Project

photo source: Times Of Malta & Retrieving Meaning, Weaving Meaning: Project Overview – Prof. Adrian-Mario Gellel

Teachers participating in this project said that they felt that the project’s child-friendly approach was much more effective than textbook learning. One teacher explained how the children, even those with learning disabilities, were completely engaged during their visit at the museum.

Museum learning manages to reach everyone, even though students have different abilities. The project, which has been running since 2014, has attracted more than 9000 students, and is an excellent example of how museums can effectively stimulate and ensure learning in children.

APP2.4 Digital Tools

APP 2.4.1 Case Study - Museum ExplorAR: National Museum Cardiff

The National Museum Cardiff is the second most popular National Museum in Wales. Each year the museum receives more than 525,000 visitors a month, more than half being repeat visitors (KEA European Affairs, 2006). The Museum wanted to explore the possibility of using new digital technologies to spice up its galleries. In the summer of 2018, the museum started an augmented reality pilot project aimed at increasing visitor engagement by superimposing graphics and animations onto physical museum galleries.

The project used the ExplorAR handheld AR unit to allow visitors to explore 3 self-led experiences. “Underwater life” was set in the Marine gallery and turned alive the static displays of sea life on display. Through the AR experience, visitors could see the humpback whale skeleton come alive and sharks swimming above their heads. In Monet’s Water Lily Garden visitors can get inspired by Monet’s water lily paintings and meet the Davis Sisters, Gwendoline and Margaret, who bequeathed more than 260 works of art to the gallery. Visitors can talk to Monet himself who speaks to them about his gardens whilst standing in the middle of the bridge. who collected most of the paintings in the gallery. Through the AR application the entire floor of the gallery turns into a garden inspired by the work of Monet.



Figure 8.3 - Photos showing use of the AR experience at the National Museum Cardiff at the Monet Water Lily Garden and the Underwater life experience.

Source: <http://cardiffmummiesays.com/>

In a review by the website “Cardiff Mummy Says” Cathryn Scott, journalist and mother of three, says that the Museum ExplorAR experience was an enjoyable one. The technology used did not detract from the exhibits themselves but rather made the visit more informative especially through the interaction with the historical characters. Children who would not normally have looked twice at the paintings had a great time interacting with the AR application (Museum ExplorAR: Immersive augmented reality experience at national museum cardiff. – MW19 | boston.) It was noted, however, that on busy days people might get in the way of the screens (external noise).

Rather than relying on image tracking or marker-less AR, the developers (Scott, 2018) used a combination of Area learning with augmented reality. This allowed the unit to know where the user is exactly in the gallery and trigger the related content. This allows users to experience the museum without any restrictions and simply focus on the visual content. The system was not limited by data networks, Wifi or GPS, which are often problematic in open busy

places. AR Data is stored within the unit itself and only statistic data is sent via WiFi whilst the units are recharging.

During the initial evaluation period of 16 weeks, the units were hired, at a minimal charge, 270 times. Users were very pleased with the experience, with 95% of them giving a 4 -5 star rating. 99.3% said they wanted to see more such experiences in the future. This pilot study is featured as a case study of an example of the use of digital tools in visitor experiences within the School of Museum Studies at Leicester University.

APP2.4.2 Case Studies – Audio Guides for the Museo Egizio (Turin)

The “Museo Egizio” of Turin, reviewed in my research section of this thesis, is the second biggest and most important Egyptian museum in the world. Included in the entrance ticket to the museum, the guide is offered as the main interpretation tool for visitors. The museum acknowledges the important and central role that the audio guide plays in the museum visit. For this and as preparation for the planned audio guide revamp due in 2019 the museum engaged Invisible Studio (invisiblestudio.it) to carry out a comprehensive training programme for its internal stake holders.

The six month project, based on the 3 main principles, visitor centred, team based and internationally oriented, stressed the importance of putting the visitor in the very centre, the need to involve multiple and varied stakeholders to include different perspectives and contributions, and the engagement of Peter Samis, one of the pioneers of museum digitization, to put the whole project in an international trends perspective.

The project team used Design Thinking, a problem solving method by the D-School of Stanford University, to tackle the audio guide redesign process. In a review of the project methodology Invisible Studios explain how Design Thinking was implemented in this project (Jam Creative Studios).

APP2.4.3 3D printing Case studies

APP2.4.3a Metropolitan Museum of Art in New York

The Metropolitan Museum of Art in New York, has a very interesting education and audience participatory programme based on 3D printing technology in order to encourage visitors to use and interact with the museum's digital collections. These can then be used to create digital models of the artefacts. The museum posted its own website guide, tutorials and walk through on buying a 3D printer or using a 3D printing service (Agency, 2017). Visitors may also download models from the MET hosted on thingiverse.com. Since the majority of people will not have their own 3D printer, the site gives links to 3D printing services which visitors can make use of.



Figure 4.3.1 - A 3D-printed creation made by morphing two separate digital artefacts (Leda and the Swan by Jacques Sarazin and Marsyas by Balthasar Permoser from the MET) into one. Source: <https://www.metmuseum.org>

Although every year hundreds of thousands of museum artefacts leave the safety of their museums to be loaned to other institutions locally and abroad, the process is a very risky, delicate and expensive one. Apart from the transport risks, museums would only loan out artefacts if they are completely sure that the venue hosting the temporary exhibit can provide a safe environment for the artefact on display. Apart from the transport risks, insurance costs and overall logistics, sometimes museum loans may end up in complex cross country political situations as was the case of the friction between the British Museum and its Greek counterpart after the British Museum loaned the headless statue of Illisos, part of the Elgin Marbles, to the State Hermitage Museum in Russia (Undeen, 2103) .

APP2.4.3b Victoria and Albert GOSH project

3D printing allows artefact replicas to be taken out of museums without ever moving the original object from the safety of the museum. In April 2018, the Victoria and Albert museum launched a project in collaboration with GOSH Arts, which is Great Ormond Street Hospital's arts programme. GOSH Arts is meant to enhance the hospital experience through Art, engaging artists as well as integrating art into as many aspects of the hospital in order to create a more relaxed space whilst at the same time helping to reduce stress for patients, their families and staff (Sherwin, 2015) . This project targeted children, within the hospital's isolation wards, awaiting bone marrow transplant. Not only could these children not leave the hospital to visit the museum but, due to their condition, contact with people is often very limited, if there is any at all. Patients

were able to interact with 3D scans of some of the objects in the museum. The digital models were further manipulated to create designs by the patients themselves. Finished projects were then 3D printed in the playroom allowing the young patients to see and feel their own creations.



Figure 4.3.2 - 3D printing allowed patients in very difficult and restrictive hospital settings to still manage to interact with museum artefacts.

Source: V&A blog

When describing the project in the official blog, Alex Flowers from the V&A said, “Taking the museum out of the walls of South Kensington to those who can’t make a visit is so important for making sure that culture and our collections are accessible to everyone. Visits to hospitals can be scary times for both patients and their families and by bringing in creative activity we want to create a meaningful distraction and engagement.”(GOSH arts.NA).

Multi-sensorial experiences make cultural heritage more accessible, especially for persons who are visually impaired visitors, have some form of learning difficulty, for children and the elderly (Flowers, 2018)

APP2.4.3c Using 3D printing to increase accessibility at the Prado museum



Figure 4.3.3 - A visually impaired museum visitor explores the 3D copy of the Mona Lisa
Photo source: npr.org - Ignacio Hernando Rodriguez/Courtesy of Prado Museum

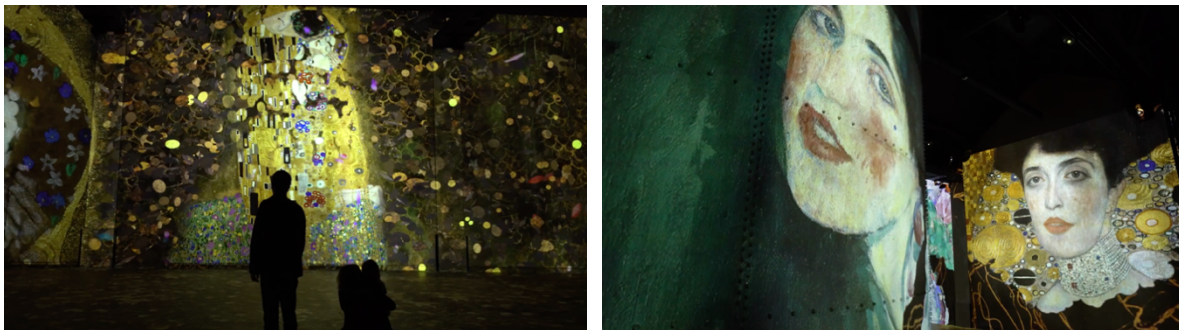
A 3D printing technique and methodology called Didú has been used by the Prado museum to make art more accessible to the visually-impaired, helping them to appreciate artworks through feeling the works. In 2015 the Prado launched a special exhibition made up of a number of 3D copies of some of its most renowned works including those by El Greco, Francisco Goya and Diego Velazquez. For the first time a museum made its works of art accessible to blind people who could feel them. Most of the visitors visiting the *Touching the Prado* exhibition were not

blind, yet they still could experience this new sensation of touching paintings. By wearing museum provided opaque glasses they could for the first time experience art through touch.

APP2.4.4a “Les Carrières de Lumières” - Baux-de-Provence

Projections have the potential to turn large big barren places like quarries or abandoned warehouses into immersive digital exhibits. Museum foundation CultureSpaces turned a former foundry in eastern Paris into a large canvas for a multi-sensory art experience. The temporary exhibition entitled “Workshop of Lights” used 140 laser projectors to project works by Gustav Klimt, Egon Schiele and Fredrich Stowasser onto 10 meter high walls spanning a total surface area of 3,300 square metres. Music by Wagner, Chopin and Beethoven amongst others complements the projections through a distributed sound system using more than 50 speakers.

Bruno Monnier the president of CultureSpaces says: “People do not learn about culture as they did in the past. The practices are evolving and cultural offering must be in step with them. The marriage of art and digital technology is, in my opinion, the future of the dissemination of art among future generations” (Neumüller et al., 2014).



*Figure 2.4.1 - screen grabs from a feature film about the installation *Les expositions de l'Atelier des Lumières en 2018*.*

Source: CultureSpaces - Vimeo <https://vimeo.com/322211663>

Disused quarries in the Baux-de-Provence have been turned into an immersive projection exhibition centre called “Les Carrières de Lumières”. Currently two different exhibitions are in place: one featuring works by Van Gogh and the other entitled *Dreamed Japan, Images of the*

Floating World. The site has been hosting similar projection-based exhibitions since 2011, and has hosted works by renowned masters such as Monet, Renoir, Gauguin, Klimt, Michelangelo, Chagall and Picasso to name a few.



Figure 2.4.2 - Photos from the Baux-de-Provence quarries showing how the bare walls have been turned into canvas for the projections

Source: CultureSpace, retrieved from <https://www.culturespaces.com/en/sites/carrieres-lumieres>

APP2.4.4b The works and life of Paul Gauguin Fondation Beyeler

In 2015, the Fondation Beyeler, presented an important exhibition of Paul Gauguin's works. Thousands of visitors attended the exhibition to view more than 50 of the French master's works. At the very centre of the exhibition, the museum set up a multimedia room allowing visitors to discover the works and life of Paul Gauguin in a fun and playful approach. Six interactive books turn conventional books into interactive light documents using projection. As visitors "leaf" through the pages, illustrations become animated, paintings transform when touched, text can be shown or hidden. These light books were very popular with visitors of all ages. A huge animated map, part printed and part projected, allowed visitors to gain further insight into Gauguin's life and travels.



Figure 2.4.3 – Screen grabs from video documentary about iart's interactive book showing how projection and interaction are used to allow visitors to leaf through a virtual book.

Source: iart; <https://iart.ch/en/-/die-interaktiven-bucher-von-iart-ein-framework>

APP2.4c Wu Kingdom Helv Relics Museum

One of the world's largest immersive interactive projection experiences can be found at the Wu Kingdom Helv Relics Museum. During the 15-minute show, visitors are told about the rise of the kingdom of Wu during the spring and autumn period. The floors and walls present a unique story telling experience. Powerful large-scale imagery and movement help the visitor travel back in time. The panoramic wall and floor create a 650 sqm metre canvas, placing the visitor in the very centre of the projection. The visitor is no longer a spectator but an actor in the story. A powerful setup of projectors, tracking cameras and interactive software create an immersive experience with real time video generation.



Figure 2.4.4. – interactive projection installation at Wu Kingdom Helu Relicssource: screen grabs from <https://player.vimeo.com/video/97433364>

APP2.4.6a Science Museum - Atmosphere Gallery, Carbon Cycle interactive game

<http://www.kingdomlondon.com/smg-carbon-cycle.html>

Designed for the Science museum in London, the “Carbon Cycle” interactive game is an example of gamification of education within a museum setting aimed at the general public and not necessarily merely at young visitors. The science museum required an interactive game that could help visitors understand the complex issues related to the world’s carbon cycle. The main objective of the game was to explain what the carbon cycle is and show how natural and man-made factors can affect its balance.

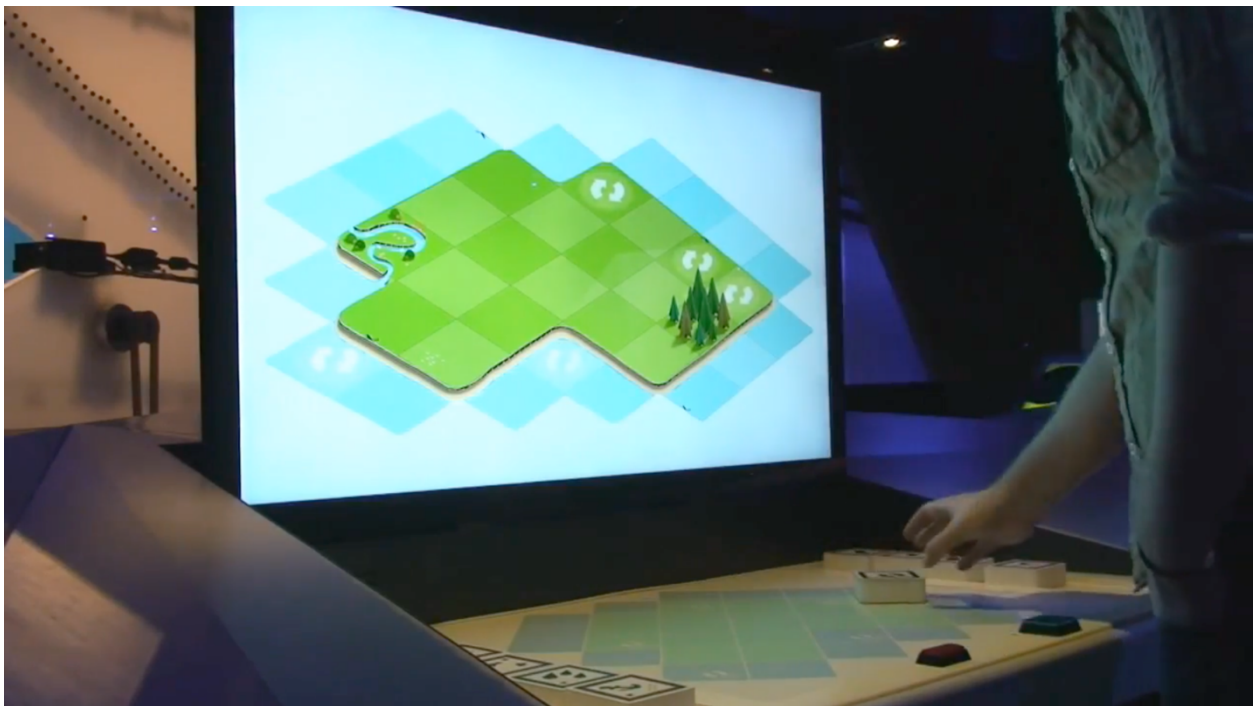


Figure 2.4.6.1 - layer placing one of the AR blocks on the printed grid to see how it will affect the balance on the carbon cycle.

Source: Kingdom X <https://vimeo.com/194544066>

Rather than simply stating what the carbon cycle is, the game is designed so that visitors can discover and explore what it is through gameplay. In order to create a hands-on game

experience, the developers created an interactive Lego-like kit consisting of various physical and digital components. These were used by players to build their own carbon cycle. Players place AR blocks on a printed horizontal grid that is also displayed digitally on a virtual island shown on a nearby screen. Each of the different blocks is related to the different natural and man-made elements that affect the carbon cycle. When the player places a block on the printed grid, this is translated into the related element and displayed on the digital island. Since the different natural and man-made elements have different effects on the carbon cycle, the player will be able to add and remove the different elements to create a balanced and stable carbon cycle. The game attracted more than 700,000 visitors in just one year and remains one of the most popular games at the Science Museum.

APP2.4.6b “Full Steam Ahead” SS Great Britain – Create your own ship

<https://www.ssgreatbritain.org/full-steam-ahead>

The SS Great Britain is a former passenger steamship turned into a museum aimed at encouraging visitors to understand and interact with the work and genius of Isambard Kingdom Brunel. The ship was very advanced for her time. Designed by Brunel, the Great Western Steam Ship Company's SS Great Britain was the longest passenger vessel in the world and held this record from 1845 to 1854.

Aardman Animations were approached by the SS Great Britain Museum and the Science museum to create a game that could be played by students at the museum, at home as well as in classrooms. Through this game, pupils are encouraged to copy Isambard Kingdom Brunel's perseverance and determination to solve challenges and problems and improve design whilst learning from mistakes.

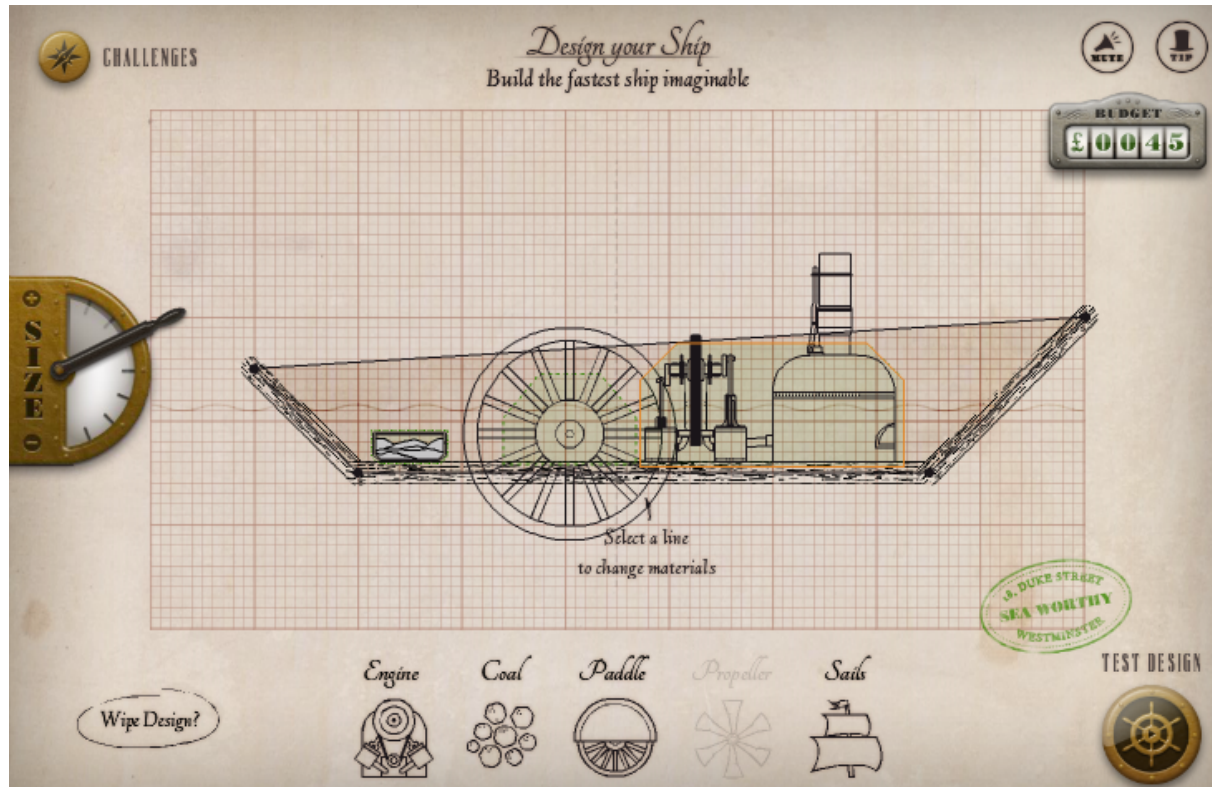


Fig. no 2.4.6.2 - Screenshot from game main design plan allowing players to modify their ship design by introducing different elements

Source: Brunel's SS Great Britain Museum website <https://www.ssgreatbritain.org/>

By going through a series of optimal design challenges similar to those faced by Brunel back in the 19th century, the players learn how to overcome these challenges by experimenting with different designs. This is done through changing different placements of ship elements such as engines, coal, the shape of the hull, adding sails and paddles. The idea is to build a ship fast enough, and strong enough to carry more cargo and offer comfort to passengers over the furthest distance whilst being strong enough to win over opponents' paddle driven ships, through the introduction of the propeller.

This project supported by the Arts Council England is targeted specifically at 8,000 school children from Bristol in Years 6 and 7 and encourage them to visit the museum. During my visit to the SS Brunel in Bristol, I had the chance to play the game on a touch screen unit at

the museum, but, due to other visitors also wanting to use the unit, I could not stay as long as I wanted in order to try out the game. The game is available online

<https://www.ssgreatbritain.org/full-steam-ahead>. The game is slick, easy to understand yet challenging enough to get players to keep on improving on their performance and you get immediate feedback following each iteration of your design.

APP2.7 Design Thinking Process

Phase 1: Empathize - The Design Thinking process starts with gaining an empathic understanding of the issue or problem that needs solving. In a human-centred design approach such as that being proposed by this methodology, empathy takes a central and very important role. It allows designers to set aside their personal assumptions and understand or feel what the other person is going through. Empathy is crucial in obtaining a valuable insight into the museum visitors' profile, needs and underlying problems that need to be addressed.

Phase 2: Define Stage - Identifying the challenge is often one of the most important steps in the whole process. During this stage, all the information and insight collected in the first stage (Empathy) is analysed and synthesized to be able to define the core problem that needs to be addressed. The problem needs to be clearly defined from a human-centred point of view rather than simply from the museum's point of view. This stage will help designers to collect ideas on how to create features and functions that will allow them to target and solve the problem.

Phase 3: Ideate - By this stage the designer has understood the users and their needs in the Empathize stage, analysed these observations in the Define stage and based on this information is ready to start coming up with ideas to solve the issues in question. There are many approaches and techniques to deal with the ideation stage. The ideation phase will allow the designer to shift through all the identified ideas to find the ones which best solve the problem at hand.

Phase 4: Prototype - Prototyping involves the creation of an early sample which is an inexpensive simplified version of the final service or product. This prototype allows users both from within the museum but also from outside to test and evaluate the proposed solution. This stage will help the designers to have a clearer view of how users would react to the solution being proposed. Prototyping offers many advantages to designers; these include the possibility to make practically real-time changes and test new iterations which takes us to the next stage.

Phase 5: Test- Prototyping will allow designers to meticulously test the final solution based on the solutions identified in the prototyping phase. Although this is considered as the final stage one can also see a loop between the last stage and previous stages until the testing is successfully completed. This is because results from the testing phase are then used to fine-tune the proposed solution and prototype in phase 4. Prototyping and testing are very powerful tools for museums, and used well will save the museum from very expensive mistakes and encourage innovation.

There is substantial literature and documentation available to highlight how Design Thinking is being used in museum settings. The following are three case studies which illustrate how the methodology was implemented to solve and redesign specific museum issues and projects which involved the use of digital tools, an audio guide project, gamification and web development.

App 2.7.1a - Case Study 1: Audio Guide project for the Museo Egizio in Turin

The first case study deals with one of the museums which I reviewed as part of my onsite research for this thesis. The Museo Egizio of Turin is the second largest and most important Egyptian history museum outside of Cairo. It also ranks as the 7th most visited museum in Italy

in league with the most important museums of Rome and Florence. Included in the entrance ticket each visitor to the museum gets an audio guide which is an integral part of the visit. The museum planned a redesign of the audio guide experience which was due to be launched in 2019. As part of this project the museum engaged the services of Invisible Studio, a London based consulting studio.

Invisible Studio used Design Thinking methodology to tackle the audio guide redesign project. In a published article entitled *How We Helped the Museo Egizio of Turin to Re-Think its Audio Guide Using Design Thinking and Paper Prototyping* (Agency, 2017a), Invisible Studio explains in detail how two specific stages, Empathy and Prototyping, were handled.

Empathy phase - Four methods were used for the empathy phase, these included; Observation, visitor interviews, immersion and interviews with internal experts. Visitor observations quite simply involved looking at visitors and observing what they are doing whilst taking note of their possible needs. Museum staff conducting these observations could quickly identify issues being faced by visitors. These observation sessions were followed up by interviewing the visitors which had been observed. These interviews were in the form of open conversations with the selected visitors but contributed to adding layers of information to the observations. Immersion involves putting oneself in the shoes of the visitors. It is astonishing how many times staff who have worked in the museum sometimes for years are stuck in the everyday routine and rarely experience the museum in the way the visitor does. In fact, there were staff at the museum who had never listened to the entire audio-guide. In this exercise, staff imagined themselves to be specific visitors and tried out the audio guide in the same way the visitor would. Whilst staff can contribute a lot from their hands-on experience with dealing with museum visitors, it was also

very important to engage internal museum expertise which is sometimes overlooked but also important as a valuable team building exercise.

Once the empathy phase was concluded, a lot of information had been collected and making sense of it was the next obvious stage. A clear picture of visitors' positive and negative experiences within the museum had been built and this was used to define which problems would be targeted and what needs would be fulfilled by the new audio guides. Brainstorming techniques were used in the ideation phase to start highlighting solutions to the problems identified in the previous phase.

App 2.7.1b - Case Study 2: Game Design for The Children's Museum in Indianapolis

Another case study which incorporates Design thinking methodology is the development of a video game "Museum Assistant: Design an Exhibit" by the Root Beer Float Studio made up of a group of undergraduate students from Ball State University, Muncie in collaboration with The Children's Museum of Indianapolis (Gestwicki & McNely, 2012). The idea of this game is for the player, as a museum volunteer, to design and create digital exhibits from the museum's physical collection. The design studio needed to create a human/user-centred approach to the game and used the Design Thinking framework to cover the whole game design.

Whilst all games will teach their users something through play (Koster, 2013), designing a game which is both entertaining but educational at the same time is a challenge. Museum Game design needs to find a balance between entertainment and accuracy (Schaller, 2011). The thirteen

undergraduates forming the Root Beer Float Studio came from different study areas ranging from economics, music technology, history, visual communications, electronic art and animation, psychology and theatre and creative writing. Although more than half the team had no previous experience in game design, the rich mix in skills and specialization matches the heuristics found in software development teams (Cockburn, 2006).

Over a period of fifteen weeks the studio used Design Thinking methodology in order to ideate, prototype, playtest and continuously iterate the prototype that would eventually evolve into the finished game. In the paper *A case study of a five-step design thinking process in educational museum game design*, Gestwicki and McNely explain the complete design process undertaken by the students and the museum stakeholders and partners. Initially, six different potential educational game subjects were identified, these resulted in a number of prototype ideas, which were narrowed down to the three most viable game prototypes, one of which was eventually chosen as the final game. Three prototypes; Photo Museum, Mystery at the Museum, and Museum Assistant, evolved, modified and changed until Museum Assistant became the final product.

Design thinking played a very important role in the production of Museum Assistant. Through this framework, the player is not simply the user but a stakeholder with whom empathy should be built. Understanding the player's needs as well as the learning context was of critical importance. In museum "serious" gaming, entertainment alone is not enough. In fact, when playtesting prototypes the team realized that although users enjoyed the game, the latter failed to meet the mission and values of the museum. The design thinking process helped the participants ensure that the design was aligned with the overall goals.

Regular stakeholder and community partner involvement and meetings encouraged empathy building. Playtesting generated a lot of discussion, and feedback often forced the team to not only reconsider player interaction with the game but also realign who the players themselves are. Meetings with the Children's museum were equally important as they sometimes revealed important points that the team had overlooked or not even considered. It also helped ensure that the game fit in the specific museum context.

This case study clearly demonstrated that empathy is a central key element of any user-centred design process. Serious game development, which needs to include specific learning objectives, must give a lot of importance to empathy both from the user side but also from the museum point of view. A clear understanding of the user's needs as well as the organisations' learning context ensures effective game development. Design thinking is not a linear approach, rapid iteration ensures that the design project evolves rapidly and on track to the original goals and objectives. The team's use of Scrum as the management framework and the design thinking methodology facilitated this iterative process.

An iterative approach to serious game design was integral to the success of Root Beer Float Studio. Rapid iteration allowed them to explore a significant design space to identify shared goals, and then to transition a design through three different stages of evolution. The iterative approach was facilitated and enabled by both the team management framework (Scrum) and the five-step design thinking model, while the tendency toward horizontal slicing proved to be an impediment.

App 2.7.1c - Case Study 3: Web development for the J. Paul Getty Museum

In an effort to redesign the Getty Exhibition web pages, a multidisciplinary team of curators, producers, designers, editors and senior staff joined forces in a two week project in January of 2014.

The team was split into 3 groups, and each group started off by interviewing visitors from one of the 3 main museum audience categories; casual visitors, enthusiast visitors and art professionals, in order to create Empathy maps. Rough prototypes were created for each type of visitor. By understanding the characteristics, lifestyle, age bracket and needs of the different visitor types attending the museum, the team could better understand what the different audiences expected.

Using brainstorming the team could explore different ideas which had the potential to improve each visitor types experience at the Getty. Brainstorming allows everyone within the team to contribute their ideas. Ideas were shortlisted and the chosen ideas moved to the prototype stage.

Through the interviews the team learnt that hardly anyone ever looked at the exhibitions section in the Getty Website before visiting the museum. A rough prototype was built to examine how the different visitors reacted to searching for information on the Getty website. The prototype provided a cheap and effective platform to test and validate the team's hypothesis.

The biggest advantage of multi-disciplinary teams, is that the different expertise backgrounds ensures that ideas spread and develop quickly. Although the project was focused solely on the webpage redesign, the findings of the team spread also to their department's

handline in-gallery signage and content interpretation who started to use the visitor-centred research to design their own exhibit displays.

Design Thinking helps the design team to follow a structured methodology which is flexible enough to allow the process to fit any museum project. It offers an excellent opportunity to museum specialists to get away from their desks and spend time within the galleries where the end-users are. By empathizing with visitors, they can refocus their vision in a visitor-oriented one. Design Thinking allows you to question assumptions before investing precious time and money. Defining the problems and opportunities clearly before attempting to find a solution will ensure that selected solution fits the problem as accurately as possible. Prototyping allows the creation of test products and services that can be modified and improved at early design stages in a very expedited manner and at a fraction of the cost of a fully working sample.

APP3.5 Site Visit Reports**App 3.5.1 – Israel Short Term Scientific Mission**

Copy of Post-visit STSM report presented to Prof Vital Shenkar College of Engineering and Design, Ramat Gan (IL)

COST STSM Scientific Report**COST Action TD1406****Innovation in Intelligent Management of Heritage Buildings (i2MHB)**

STSM Topic: The use of Digital Tools in interpretation centres and their impact on the visitor experience

STSM Researcher: Tony Cassar, UOM - Media Knowledge and Digital Arts, Msida (MT), Malta, tony@cyberspace.com.mt

COST STSM Ref. Number: COST-STSM-ECOST-STSM-TD1406-37156

Period: 2017-04-25 to 2017-04-30

Location: Shenkar College of Engineering and Design, Ramat Gan (IL),

Host: Rebeka Vital, rebekavital@gmail.com

REPORT:

Scope of scientific mission: “Tony Cassar graduated in 1999 with Honors in Bachelor of Commerce with specialization in Management and Marketing. He is currently reading a Masters by research in the field of digital tools in interpretation centres. He is an MC member in Cost action TD1406 related to innovation in Intelligent Management of Heritage Buildings. For the last 23 years he has led his own company specializing in multimedia design, with the last 8 years focusing on interactive systems for museums.

During the planned scientific mission with the Shenkar College of Engineering and Design, Mr. Cassar researched how digital tools are being used in Interpretation centres in Israel. The research looked at the extent that such tools are used in specific locations, the reactions of the visitors to such tools and how such tools improve or not the experience to the interpretation. This is a report that summarizes the research that was carried out.

This intensive short site visit to Israel, carried over 6 days, allowed me to visit various important historical places in Israel and discover ways how digital tools were being used to engage visitors to such sites. The following report is in the form of a daily diary, highlighting the sites visited. Visiting so many sites in such a short visit was only possible with the valuable assistance of my host as well as the liberty to move around, which was possible only by driving around the country.

Tel Aviv Shankar College of Design

Photo: Tel Aviv Shenkar College of Design Building

Source: Taken by myself.

Shortly after having arrived in Tel Aviv Ben Gurion airport, following an early morning direct flight, I picked up the rented car and drove to Shenkar. Design. Engineering. Arts where I met my host Prof. Rebeka Vital. The college is situated in a heavily urbanized location since it

is located in a built-up area of town, and part of it incorporates a redeveloped old cotton processing factory.



Photo: Main Design Lab

Source: Taken by myself.

Over the years “Shenkar - Engineering Design Art” has become one of the leading colleges in Israel. I was welcomed by Professor Vital who toured me around the college and explained how every year, graduates from Shenkar find attractive positions in research and the industry, exhibit their works, participate in competitions and win prestigious awards.

Prof. Vital gave me an overview of the different Bachelor’s and Master’s degrees offered through the different faculties. The college has two main faculties: engineering and design. These two specialties allow Shenkar to offer a unique multidisciplinary offering to students and academics. This allows them to study and work with cutting-edge technologies combined with contemporary design and artistic concepts. Students are exposed to a wide variety of disciplines from the three different faculties.

Founded in 1970, Shenkar was originally known as the “College for Fashion and Textile Industry”. It was setup with the main aim of providing Research and design Services and skilled

workers for the Israeli Industry. Various academic degrees including PhD programs are offered in design and engineering at Shenkar today.



Photo Left: An experimental art installation
Photo Right: One of the lecture design lecture rooms
Source: Taken by myself.

One of the departments I was very much interested in was the Department of Visual Communication headed by Mr. Dekel Bovrov. The department encourages students to use modern digital tools such as Web, Smartphones, e-Books, Tablets, GPS and VR systems as well as many day to day digital gadgets to create an immersive visual and communications world.



Photos from the college library which was designed by the students themselves. The layout encourages students to work in teams.

Source: Taken by myself.

Whilst being shown around the college I could not help but notice every innovative approach in creating a very relaxed atmosphere for students even though the college does not have access to large green open spaces, being located in the middle of a heavily urbanized area. The library itself was redesigned by an ex-student of the college, who despite the limitations faced specially related to budget, managed to create a very unique and user-friendly study environment.

In the afternoon I had a long discussion with Prof Vital about a number of case studies which Shenkar was involved in. We focused primarily on two specific projects which I was planning to visit in the following days. The first was the restoration project in Old Acre, a joint research project conducted by Shenkar and the University of Milan. Acre is a UNESCO heritage site and it is one of the oldest port cities in the world. It is thus important to preserve the many different era artefacts which can be found here. The research project used state of the art equipment including photogrammetry and laser scanning. The application of such technologies in this project highlighted the benefits of new digital documentation technology. 3D imaging allows more accurate research and restoration of historical buildings. Apart from our discussion into the technologies used, we even discussed more practical social aspects of the project relating to how the inhabitants of old Acre reacted to the project. The challenges faced by historical heritage sites which are also inhibited environments and not simply an open-air tourist site.

The digital documentation project of Masada was another case study which we discussed in detail. The ancient fortification (Hebrew: metsada "fortress") is located in the southern district of Israel on the very top of an isolated plateau overlooking the Dead Sea. Herod the great built a fortified palace on the mountain between 37 and 32 BCE. The site has a very strong symbolic

meaning to the Jewish nation as it was the site of a siege by Roman Troops. The siege ended with a mass suicide of the Sicari rebels and their families who preferred to die rather than surrender to the Romans.

This research project carried out over a 3-year period, used laser scanning technology and aerial as well as ground photogrammetry to document the whole archaeological site. This research project used different documentation methodologies and by comparing the analysis the different pros and cons of each methodology. The project also deals with data management of complex databases which in turn can be used for a better understanding of an archaeological site.

Acre (Akko) – Old Town and Hospitalier Fortress

My visit in Acre focused primarily on the Hospitalier Fortress in Old Acre. The fortress is built on the north-western section of the city, adjacent to the northern wall of 12th century Acre. This magnificent building is rich in history as it played a very important part in the crusades.





Photo 1(top left) showing a model of the fort.

Photo 2 (top right) showing one of the main halls within the fort.

Photo 3 (above) showing the main courtyard within the fort.

The Hospitaller Order, which thrived in Jerusalem during the First Crusader Kingdom (1187-1099), transferred its headquarters to Acre during the Second Crusader Kingdom (1291-1191).

The Hospitaller, who had a quarter there during the First Kingdom, returned to Acre, expanded their headquarters and rebuilt the site, which consisted of two to three floors around a central court as well as underground sections – water reservoirs and a sewage system. It was not the entire site that was excavated; to date, an area of about 5000 m² was excavated, which encompasses the central court and the northern, eastern and southern wings. The western wing has yet to be excavated. Visitors of the site will primarily be exposed to the remains of the first floor of the Hospitaller headquarters since the upper floors were destroyed by the Muslim conqueror and the ravages of time. The Ministry of Defense's Underground Prisoners Museum is currently located above the larchaeological site.

Acre's Hospitaller quarter houses three main buildings: the headquarters (Knights' Halls); St. John's Church south of the headquarters (now a municipal community centre in the Ottoman Saraya House); and the hospital south of the church that is yet to be excavated.

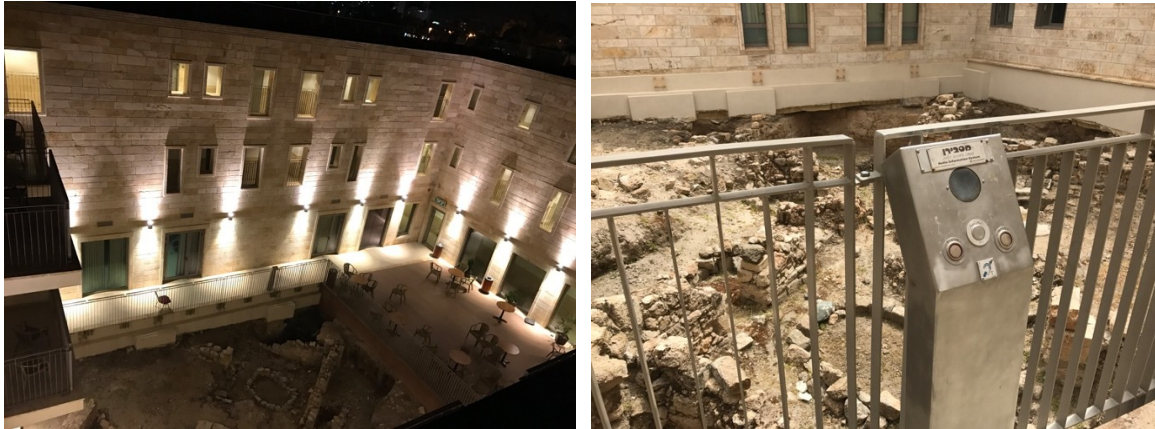


Photo left: view of the Akko hostel built around the ruins.

Photo right: an audio station (not functioning) meant to explain the ruins to the visitors.

Source: Taken by myself.

The Akko Hostel – knights Youth Hostel, in which I was staying is built on a historical site which is still accessible to visitors. This is an excellent example of how heritage sites and commercial activities can not only coexist but even create added value to each other. Multilingual audio posts installed around the archaeological ruins allow visitors to understand what they are seeing and help them appreciate better the site they are standing on.

As I walked round the fortress, I was particularly interested in the innovative audio guiding system used, which is location activated. As the visitor walks around the different halls and buildings, numbers on the floor invite the user to approach them, once in close proximity the visitor's audio guide is automatically activated with the narration in the language of choice of the user. The system which is probably activated by some form of RF id tagging or GPS location had various advantages.

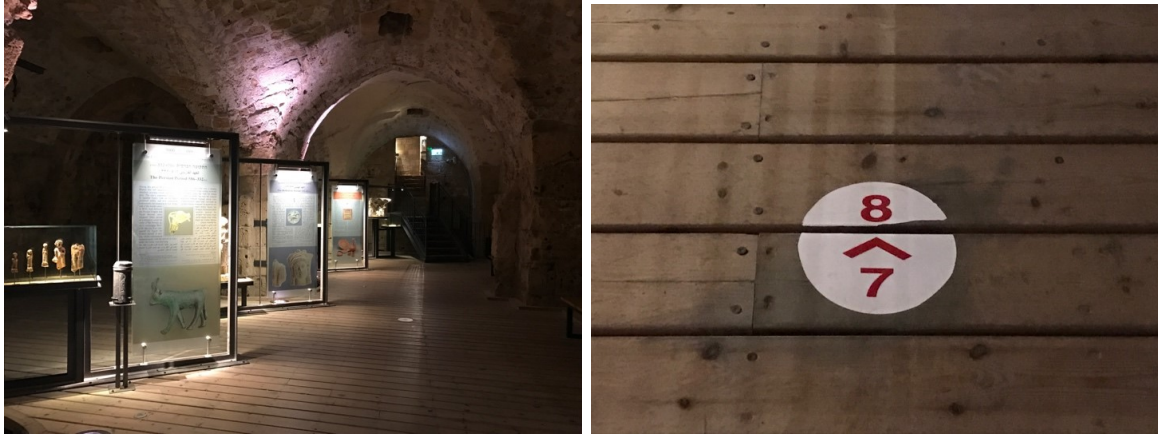


Photo left; One of the corridors with exhibits within the fort, one the floor one can see one of the audioguide sticker signs meant to help the visitor orient himself whilst walking around and listening to the audio guide.

Photo right: Close up of sign showing visitor is moving from zone 7 to zone 8.

Source: Taken by myself.

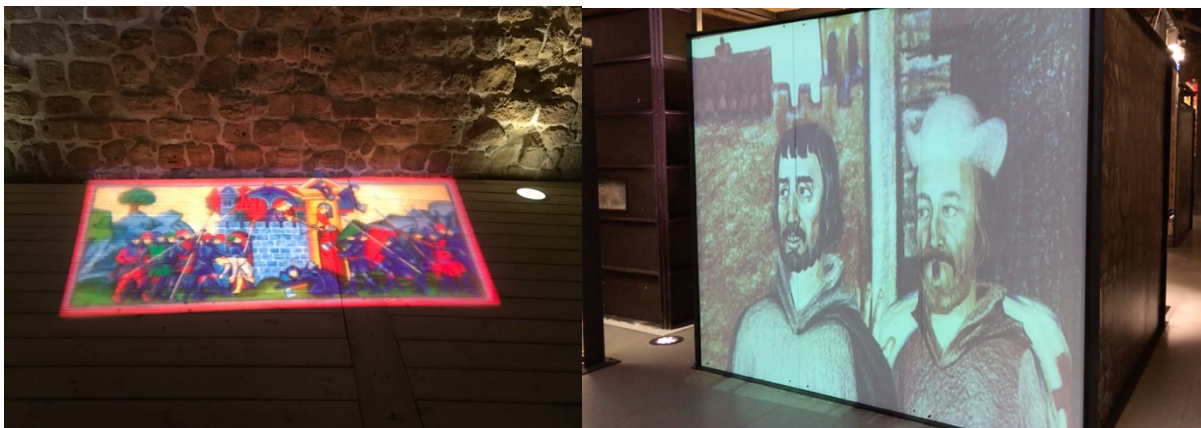


Photos of the sensor driven audio- guide unit which did not require any user intervention to select audio files.

Source: Taken by myself.

The stickers on the floor indicate the path that the visitor should follow but the visitor does not have to interact with the audio guide as this is activated automatically as the visitor walks around.

This system is very user intuitive and extremely simple to use. There is practically no user intervention to activate the narrative at the different points. All that the visitor has to do is walk around the heritage site, explore the different rooms and exhibits and once he is in proximity of such displays the audio guide is activated. In areas where there are multiple points of interest multiple numbers would be displayed on the floor which are extremely easy to follow.



Photos of large format projection used for storytelling.

Source: Taken by myself.

The interpretation centre uses other forms of digital tools to enhance the visitor's experience. These include projections in the form of animations and storytelling. Such animations are excellent to attract the attention of visitors of all ages.

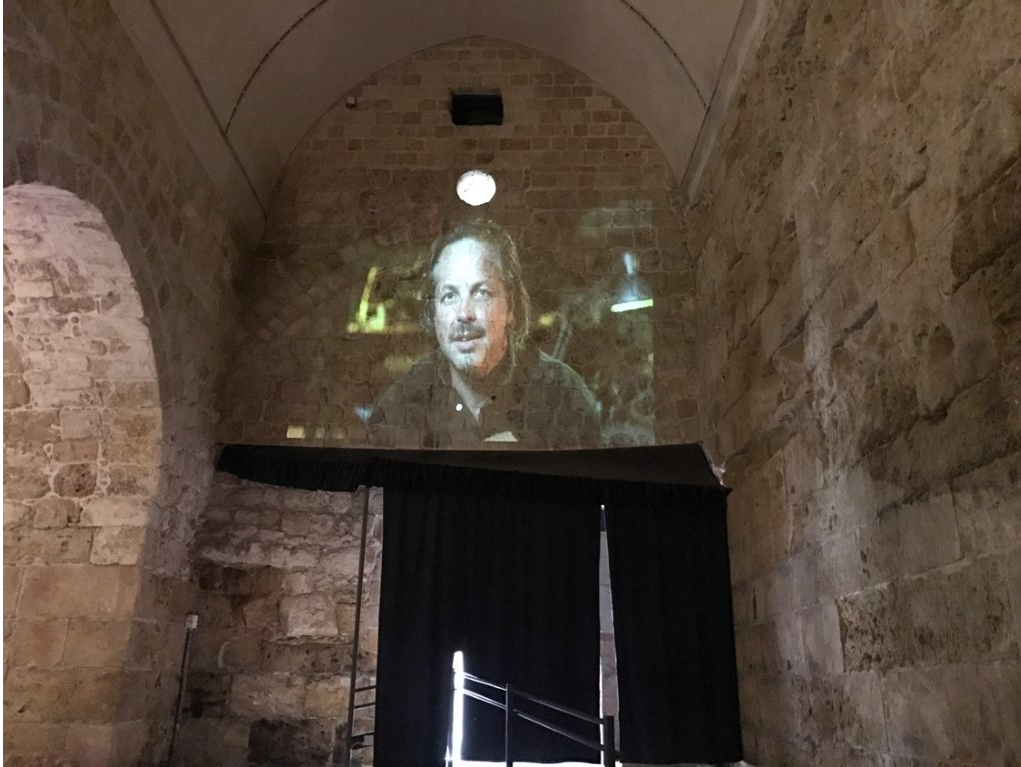


Photo showing one of the halls turned into a projection room with the walls being used as canvas.
Source: Taken by myself.

A multimedia projection room allows visitors to watch a 10-minute video about the history of Acre over the centuries. The documentary shows an artist putting together a collage which represents the various layers of history of Acre. Again, what has impressed me most in this video documentary is the simple and clear way how such information is passed on to the visiting public of all ages.



Photos of games and puzzles which many visitors tried to use whilst visiting.

Source: Taken by myself.

Visitors are also invited to try various hands on games (which although not digital tools directly) are a very interesting feature of how visitors can be engaged with historical displays.

Cesarea Maritima

Caesarea Maritima is an Israeli National Park in the Sharon plain, including the ancient remains of the coastal city of Caesarea.



Photo showing the ancient roman aqueduct in Cesarea.

Source: Taken by myself.

The city and harbor were built under Herod the Great during c. 22–10 BC near the site of a former Phoenician naval station. It later became the provincial capital of Roman Judea, Roman Syria Palaestina and Byzantine Palaestina Prima provinces. The city was populated throughout the 1st to 6th centuries CE and became an important early centre of Christianity during the Byzantine period, but was mostly abandoned following the Muslim conquest of 640. It was re-fortified by the Crusaders, and finally slighted by the Mamluks in 1265.

The ruins of the ancient city, on the coast just about 2 km south of modern Caesarea, were excavated in the 1950s and 1960s and the site was incorporated into a new national park in 2011.



Photo showing static didactic boards near various important locations along the heritage site explaining the view and the historical relevance of the ruins. Available in two languages Hebrew and English these signs were extremely useful to visitors.

Source: Taken by myself.

Static sites all over the heritage site explain in English and Hebrew. These are very low tech but the site has other digital tools which make a visit to Cesarea Marittima very interesting. These include an onsite projection room which shows a documentary about the heritage site in various languages.

The site also offers a VR experience which allows the visitors to “see” a virtual port and city, viewing how the city looked like in ancient times. I did not get a chance to view the VR experience.

Jerusalem



Photos showing views from the old city of Jerusalem.

Source: Taken by myself.

This was my first visit to the city of Jerusalem. I was impressed by the modern part of Jerusalem, full of beautiful hotels and top fashion brand shopping malls. But what really impressed me was the old city of Jerusalem. The city is steeped in millennia of history, cultures and religions all living together in such a small place. The city does not offer any particular digital tools to help you explore it, though I did use some apps for site recommendations.

One particular app which I found very useful, both to drive around Israel but even to find my way within Jerusalem itself, was an app called Sygic. This app, which does not require internet data to be activated, allows you to use a very accurate GPS navigation to find your way around.



Photo left: entrance to the Church of the Holy Sepulchre.

Photo right: the holy sepulchere.

Source: Taken by myself.

The Church of the Holy Sepulchre is a church in the Christian Quarter. The church contains, according to traditions dating back to at least the fourth century, the two holiest sites in Christianity: the site where Jesus of Nazareth was crucified, at a place known as "Calvary" or "Golgotha", and Jesus's empty tomb, where he is said to have been buried and resurrected. The tomb is enclosed by the 18th-century shrine, called the Aedicule. Unlike other cathedrals in Europe there are no digital tools to help the visitor explore the church. There are no audio guides or signage available. I was lucky enough to follow a guided tour which gave basic explanation of the different parts of the church and exhibits.



Photo left: Scenes showing people praying next to the wailing wall.

Photo right; indoor male prayer area.

Source: Taken by myself.

The Western Wall or Wailing Wall is a relatively small segment of a far longer ancient retaining wall, known also in its entirety as the "Western Wall". The wall was originally erected as part of the expansion of the Second Jewish Temple, begun by Herod the Great, which resulted in the encasement of the natural steep hill known to Jews and Christians as the Temple Mount, in a large rectangular structure topped by a huge flat platform, thus creating more space for the Temple itself and its auxiliary buildings.

My visit to the Western wall and the synagogue nearby was a unique experience but lacked explanation. Had I not researched the site and traditions before I would have been a very uneducated spectator. The site offers no digital tools which I could use such as audio guides or information displays.



Photos showing entrance to the “A look to the Past” Virtual reality Experience.

Source: Taken by myself.

After the Six-Day War, the Ministry of Religious Affairs began the rigorous process of uncovering the entire length of the Western Wall. The Western Wall Tunnels were finally

excavated almost twenty years later. In spite of the numerous obstacles this project initially proposed, archaeologists were able to uncover 2,000 years of Jerusalem's rich history. These discoveries included ancient cisterns, aqueducts and remains of the Herodian road which ran parallel to the Temple Mount.

It was by the entrance of the Western Wall tunnels that I discovered a Virtual Reality experience called *A Look into the past*. This unique, innovative, and exciting experience uncovers the architectural beauty, enhanced by Levites singing, and highlights the glory of the place that was the heart of the Jewish nation.

The Second Temple was the cultural and spiritual centre and pilgrimage destination of the Jewish people. Our sages tell us that whoever had not seen the Temple had not seen a beautiful building in all his life. The Temple was destroyed about 2,000 years ago, but continues to play a central role in Jewish identity and in the story of Jerusalem.

Using state-of-the-art technology, the Western Wall Heritage Foundation has now made it possible for visitors to see the Temple. This groundbreaking project combined the skills of researchers, animation and computer experts, and artists who created this computerized, detailed, and precise view of the Temple. Special goggles and chairs that swivel allow visitors to have a 360° perspective of standing at the Temple as it was many centuries ago.

The narration accompanying the experience provides in-depth and fascinating information about the glory days of ancient Jerusalem.

Masada Dead Sea

Photo of one of the rooms within the palace. The black line shows the original parts of the rooms.
Source: Taken by myself.



Photo showing view from the top of the Mesa overlooking the Judean Desert, and the Dead Sea
Source: Taken by myself.



Photos of the large projection room showing a very interesting documentary explaining the history and cultural importance of this historic site.

Source: Taken by myself.

The visit to Masada was quite challenging as it was boiling hot, but totally worth the trip. The fortress is built on top of a mesa, which I reached via funicular. I could immediately appreciate the huge amount of excavation and restoration work which the site has undergone as well as visualize the project explained to me on my first day in Israel by Prof Vital.

App 3.5.2 – Italy Short Term Scientific Mission

Copy of Post-visit STSM report presented to Dr. Massimo Migliorini, SiTI – Istituto Superiore sui Sistemi Territoriali per l’Innovazione,

COST STSM Scientific Report**COST Action TD1406****Innovation in Intelligent Management of Heritage Buildings (i2MHB)**

STSM Topic: The use of Augmented Reality, Virtual Reality and digital tools to enhance the visitor experience in museums and cultural heritage buildings.

STSM Researcher: Anthony Cassar 477474M Cassar, UOM - Media Knowledge and Digital Arts, Msida (MT), Malta, tony@cyberspace.com.mt

COST STSM Ref. Number: ECOST-STSM-Request-TD1406-41477

Period: 20th October 2018 – 28th October 2018

Location: Turin, Florence

Host: Massimo Migliorini, SiTI – Istituto Superiore sui Sistemi Territoriali per l’Innovazione, Department: Security and Business Models for Energy Networks and Infrastructures

To whom it may concern,

Tony Cassar graduated in 1999 with Honors in Bachelor of Commerce with specialization in Management and Marketing. He is currently reading a Masters by research in the field of digital tools in interpretation centres. He is an MC member in Cost action TD1406 related to innovation in Intelligent Management of Heritage Buildings. For the last 23 years he has led his own company specializing in multimedia design, with the last 9 years focusing on interactive systems for museums.

During this scientific mission to Italy, he was a guest of SITI – Istituto Superiore sui Sistemi Territoriali per l’Innovazione, Department: Security and Business Models for Energy Networks and Infrastructures where he, together with his host Dr. Migliorini, explored the various possibilities of using AR and VR in cultural heritage settings and museums. As part of his trip Mr. Cassar also visited a number of museums in Turin and Florence where he could see how different digital tools were being used to improve the visitor experience within these sites. This report gives a detailed review of these locations and meetings.

Museum Egizio

Address: Via Accademia delle Scienze, 6, 10123 Torino TO

Website: <https://museoegizio.it/>

Visit Liason Person: Elisa Fanetti, Ufficio Comunicazione e Marketing

The Egyptian Civilization has been known to the western world since the Ancient Greece era. It was Herodotus himself, the father of history who in the 5th. Century BC dedicated book 2 of his Histories to Egyptian civilization. (Herodotus, 1910) Plato, the great philosopher in his letter 7 wrote about the desire that the final part of the education of anyone who should consider himself educated should include a trip to Egypt, (Plato, 1952). The Egyptian civilization has always aroused great interest in the west. In the 19th century, this interest resurfaced and became the subject of study, thanks to the work of Jean –Francois Champollion, who in 1822 was able to decipher the hieroglyphics.

The Egyptian museum was started as a need to study this ancient civilization through the collections of antiquities. The Egyptian Museum in Turin, is the oldest and second largest museum completely dedicated to ancient Egypt after the one in Cairo. The museum was established in 1824 when King Carlo Felice displayed a purchased collection of Egyptian antiquities. The museum has been open to the public since 1832. Over the years, the collection at the museum continued to grow through acquisitions and private purchases. Between 1903 and 1937 the museum, under the directorship of Ernesto Schiapparelli, conducted a series of archaeological excavations in Egypt, which resulted in a growth of more than 30,000 important artefacts for the museum (Cosimo, 2015).

The *Museo Egizio* is not just an antiquities museum, but also an archaeological one. The wish to put into context how the collections came to be can be clearly seen in the way the exhibits are displayed. With every entry ticket, users get an audio guide. Groups with a tour guide used a different receiver / transmitter system where the guide gave the explanation. My observations are focused on the multimedia guides for individual users. The multimedia units are in fact touch screen players with connected earphones. The guides have 3 set tour types in the main tour selection menu; a full long tour, a short-abridged tour, and a tour specifically designed for children.

The tour for children uses a cat themed narrator's voice and simplified explanations of a different selection of artefacts were available. As I sat in the different halls, I could see that children were very interested in what they were seeing. They were navigating through the touchscreen menu on their own, and it was clear that their ability to use phones and tablets made using these guides a natural experience for them. I did see a few older visitors struggling to use the controls of the audio guide. I myself could not find from where to raise the volume of the unit. I could see Parents providing extra tips or explanations to children who were showing a lot of interest in what they were seeing. There were also many Children taking photos of artefacts - taking memories with them.

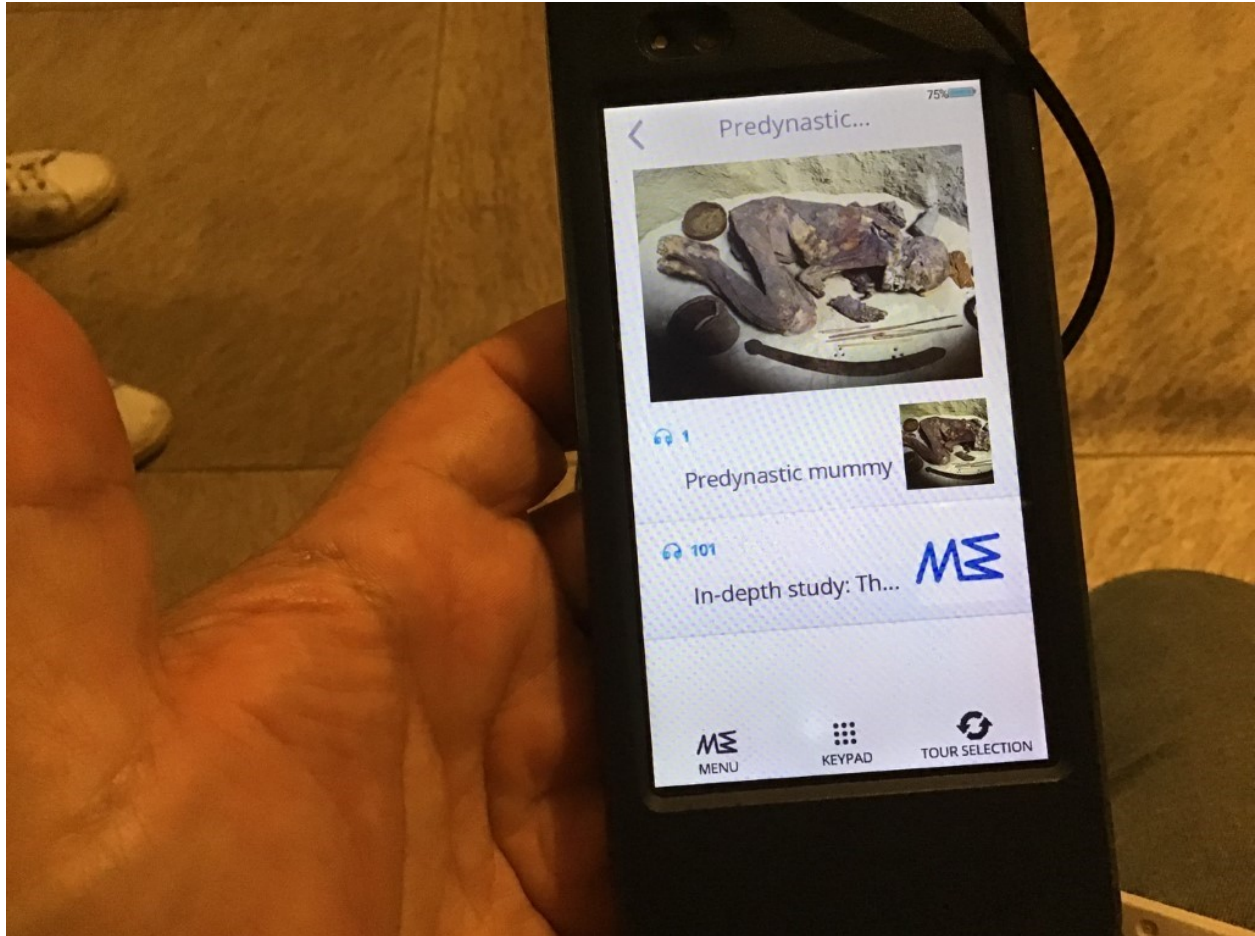


Photo of the screen-based multimedia audio guide showing closeups of the artefacts, and two levels of information. The first is an explanation of the artefact itself whilst the second playback explains the mummification process.

Source: Taken by myself.

The multimedia guide allows you to use a menu of sequential explanations arranged by floor and hall. Alternatively, the user can jump to a specific explanation shown by a number next to the artefact by keying in the number directly into the unit. The audio guide offers additional in-depth explanations for some of the artefacts. For example, the Predynastic mummy shown below has a basic explanation of the artefact, then extra info for visitors who are more interested in the mummification process.

One of the advantages of the screen embedded into the audio guide is that you can view and learn about artefacts even if you are not immediately in front of the artefact itself, either because other viewers are partially blocking the view or if you are resting on a bench in the Hall. I could see various visitors resting on the stools provided in the halls, listening about the artefacts on display, without actually getting up to see the artefact itself.

The use of introductory mystic Egyptian music in some of the artefacts focusing on stories of individuals helps create an even more engaged visitor experience, and helps distinguish between generic explanations and stories related to individuals.

The museum also made use of a few large screen monitors to display mini features about some of the narratives. These features used 3D recreations to show how the artefact would have looked in its original state.

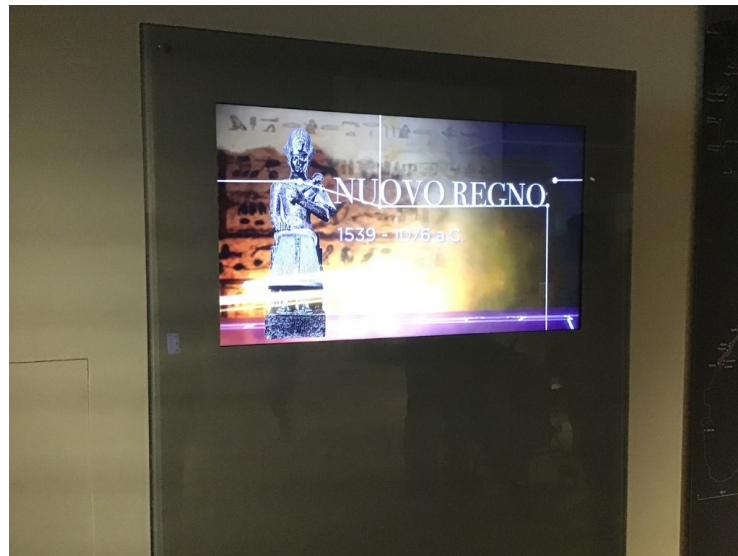


Photo showing one of the digital signage screens spread around the various halls of the museum providing visual interpretation of the narrative of that hall.

Source: Taken by myself.

The learning lab, located on the last floor in the museum, is a collaborative experience between the Museo Egizio and Bricks 4 kids, (Bricks 4 kidz - kids franchise | we learn, we build,

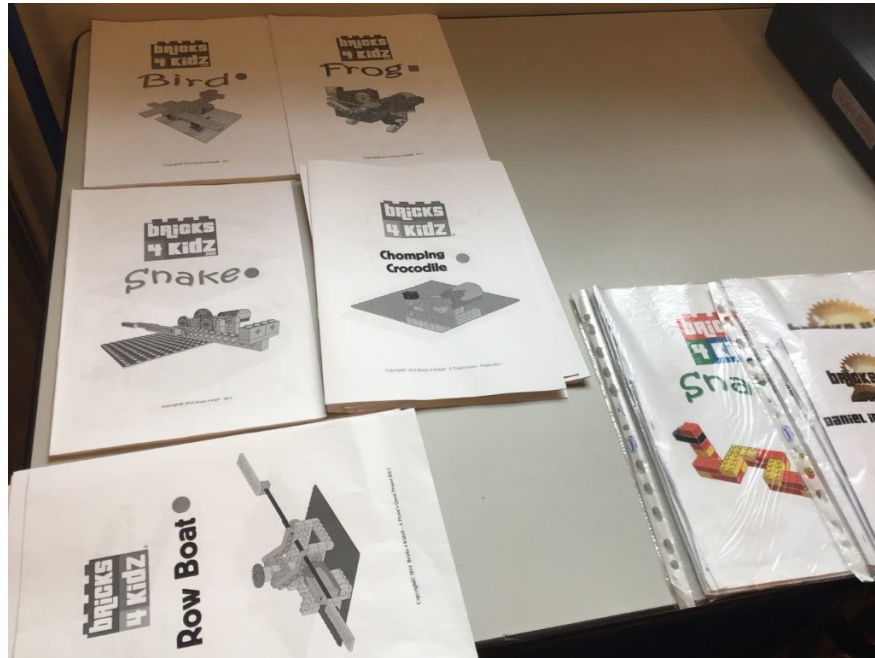
we play with LEGO® bricks.). After families finish their visit in the museum following a trail along the river Nile, learning about sacred Egyptian animals and construction, they come to the lab to construct themselves some of the animals they have seen in the Nile route. There are different difficulty levels mostly related to the child's age.

The children together with their parents will follow instructions on how to build the tasks outlined. To carry out these activities, they use an easy to use, illustrated instruction manual, very similar to an IKEA assembly manual. More difficult projects allow the children to modify components to experiment with concepts of physics, such as movement, where, for example, by using different wheels they can see how this changes friction and ease of movement. This is a fun way of applying scientific concepts to recreate objects they have seen in the museum. I could observe that the children were very interested in what they were creating, and it was a great bonding experience between parents and children.



Photo showing the lab room where children and their parents built projects based on the artefacts that they had seen in their museum tour.

Source: Taken by mysekf.



Photos showing the easy to follow instruction manuals for some of the projects that the children had to build based on the artefacts in the museum.

Source: Taken by myself.

Royal Palace, Turin

Palazzo Reale, Armenia, Galleria Sabauda, Capella del sindone

Address: Piazzetta Reale, 1, 10122 Torino TO

Website: <https://www.museireali.beniculturali.it/palazzo-reale/>

The Palazzo Reale in Turin is one of the official residences of the House of Savoy.

Although built in the 16th century it underwent modernization in the 17th century. The palace includes the Capella della Sindone, built to hold the world-famous Holy Shroud. The building was turned into a museum in 1946 after it fell under state ownership.

The main palace is very rich and full of magnificently decorated rooms. There are no audio guides, which is a pity as the only information about the rooms are small didactic boards available in four languages. There is no explanatory information about individual paintings or artefacts. Most people started off reading the didactic in the first rooms but gradually lost interest and just walked along the interlinked rooms, I stayed in each room observing the visitors.

Visitors with children tended to spend some time “explaining” stories to their children until the children got quickly fed up and tended to rush out of the rooms to find more interesting sections. Unlike the Museo Egizio there were no audio guides and I saw no children taking photos. I could see a big difference between the two museums’ visitor experience. Whereas in the Museo Egizio the multimedia guides helped visitors to appreciate artefacts much more by understanding the stories behind them, at the Royal palace, visitors were awed by the opulence of the richly decorated rooms but nothing else. I am sure that such a rich palace had a lot of stories to offer, both related to its history and to the use of specific themes in paintings and decorations to reflect specific messages which the royal family wanted to convey.

The Capella del Sindone is located in the western wing of the Palace. More than just a relic, the shroud was the Savoy Family's most treasured possession. The chapel, was meant to showcase the shroud but to also offer it security, deeply located within the royal apartments. The king could easily access the chapel through a portal in the royal apartments. The Shroud was not just a relic, it was their most important treasure, far more important than any crown or jewel. The chapel designed to display and store it, but also to protect it, was located inside the royal apartments.



Photo showing the use of digital signage by visitors watching the looping explanatory video prior to entering the Capella del Sindone.

Source: Taken by myself.

Outside the chapel of the Holy Shroud there was a big screen TV showing a looping video with an interesting explanation about the history and the symbolism used in the design of the chapel

by Guarino Guarini. It also gave a quick overview of the restoration process following the severe damage of the chapel caused by a fire in 1997. (Tv2000it,) The video was in Italian with no sub titles. Visitors who did not understand Italian could not understand much of what was being said and after a short while moved on.

The introductory video was very helpful when visiting the magnificently restored chapel. It allowed me to look and understand the specific symbols in its design. It also allowed me to appreciate more the huge job involved in the restoration process.

Outside the chapel, were 3 VR stations, where visitors could wear the headsets and explore the chapel. When I arrived at these VR stations, there were quite a few people trying them out or waiting for their turn. I could not help but notice how the people were reacting. Most of them, at a certain point, were gasping out loud, trying to touch imaginary surfaces with their hands and turning their heads round looking at imaginary spaces. Every single person who viewed the VR presentation had words of praise and appreciation to what they had just seen. The VR presentation allows the visitor to float within the chapel, exploring the different levels, symbols and decorations It gives a vivid description of the 1997 fire and the mammoth restoration job which followed. The 360° video allows the visitor to look at what he wants rather than what is simply being presented to him. The immersive experience of the VR headsets helped visitors become part of the presentation itself.



Photo showing visitor wearing the tethered VR headset outside the Capella del Sindone, Royal Palace, Turin. Observing the reaction of the visitors wearing the headset was very interesting as practically all of them became completely immersed in the brilliantly produced VR presentation. Source: Taken by myself.

Museo del Cinema

Address: Via Montebello, 20 / A, 10124 Torino TO

Website: <http://www.museocinema.it/it>

The Mole Antonelliana, Turin's most iconic building, has been since 2000 the home of the Museum of Cinema. Designed by architect Alessandro Antonelli, The Mole was completed in 1889. Initially designed to serve as a synagogue, it was later bought by the city to serve as a monument for national unity. The museum has 4 main areas dedicated to the Archaeology of Cinema, the Cinema Machine, the poster gallery and the huge Temple Hall.

The museum starts by introducing the user to the archaeology of cinema. This section of the museum helps the visitor realize that cinema did not just happen but developed over many years as a result of man's wish to capture, recreate memories, and reproduce the world which surrounds us. The laws of optics held the secrets to the great inventions related to the cinema. This part of the museum lets visitors explore technologies such as the camera oscura, magic lanterns and toys that simulate movement. The museum houses one of the most important collections of artefacts related to development of photography, which was the most important step towards the creation of cinema. The visitor can not only learn about the archaeology of cinema but also touch and experiment with reproductions of equipment in order to learn about these machines and how they worked.

The Cinema Machine explores the world of movie making, which is a complex hard work of a team of artists and cinema professionals. Film making is a collective creation that requires the hard work and input of the team. I found this section of the museum particularly

interesting since it reflected my ideas for the multidisciplinary approach when designing visitor experiences in museums.

The Poster Gallery is a selection of posters from the museums' collection which takes visitors through a journey in time. The history of cinema from the early years to the 21st century, American classics, Italian cinema, the French new wave, German cinema and more were available to visitors to appreciate the art of poster design.

The Temple Hall is the heart of the museum and offers a spectacular view of light and sounds and together with the architecture of the Mole creates a unique visual feast. The main hall is flanked by 13 themed areas dedicated to the cult of the cinema. The multimedia guide offers a sequential tour of these spaces starting from Turin's legacy with cinema. In the middle of the Hall, visitors can stretch out on red chezlounges which are equipped with headrest stereo speakers and watch various short films and anthologies dedicated to Italian cinema, including films from the silent and sound eras. The cinematic and museum experience makes sure to remind the user of the location of the museum. The inside of the mole is exposed every 15 minutes as the lights switch off and the curtains covering the windows open allowing natural light to flood the inside of the Mole



Photos above show one of the exhibits set out like a 70's living room, encouraging the visitor to think about how cinema blurred the lines between through or false. Audio visual digital tools were used to communicate the message.

Photo showing the various free digital interpretation tools on offer to visitors apart from the standard audio guides. This was one of the few museums I visited where the audio guides were not included in the entrance price and had to be purchased separately.

Source: Taken by myself.

SiTi – Istituto Superiore sui Sistemi Territoriali per l’Innovazione

Dr. Massimo Migliorini - Department: Security and Business Models for Energy Networks and Infrastructures.

Dr. Massimo Migliorini welcomed me to “**SiTi - Higher Institute on Territorial Systems for Innovation**” which is a non-profit organization setup in 2002 as a joint venture between Compagnia di San Paolo and Turin Polytechnic. SiTi is involved in research and training initiatives involving socio-economic growth and innovation, focused on 4 primary sectors; Environmental Heritage, Land Safety, Logistics and transport and urban requalification.

The highlight of my visit to SiTi was undoubtedly the time I spent in the VR laboratory trying out different VR gear and equipment. Here I could experience firsthand the latest technologies in the field of Virtual reality, including wireless and tethered VR Head gear, 360° video cameras to be used in VR and AR. Trying out all these different active and passive VR and AR projects clearly demonstrated the huge potential that this technology can offer cultural heritage interpretation. One of the projects which I tried involved a training simulation using VR for firemen. The VR headset and hand joysticks allowed me to use firefighting equipment, pickup tools from the floor and put out a fire as if I was in a real life scenario. This kind of technology can bring to life historical settings, immersing the visitor into the actual scene. Unlike passive VR and AR, fully active immersive experiences, allow the visitor to interact with artefacts, touch and pickup things and explore all aspects of the immersive scene.

Politecnico di Torino is also a partner of the RESCULT project, led by SITI. Dr. Migliorini accompanied me to the Politecnico di Torino at DIATI, to talk with the group of prof. Andrea Lingua.

A number of meetings and presentations were organised related to research and use of digital tools in the cultural heritage sector. During this visit I could see firsthand how technology is being used to get a better understanding of cultural heritage in terms of surveying, scanning, 3D reconstruction, data collection and interpretations. I could also see a number of projects implemented by the different research teams in terms of digital tools implementation in the cultural sector. Projects included the use of signal beams in heritage buildings to track movement, 3D scanning and reconstruction, 3D printing and aerial data collection using a variety of sensors and drones.

During my visit at SiTi, Dr. Migliorini gave me an Indepth overview of the EU funded project ResCult, (<https://www.rescult-project.eu/>) of which SiTi is a lead partner, which aims at using digital tools in order to bolster the resources of Civil Protection agencies in their effort to prevent and mitigate negative effects of disasters on Cultural heritage sites. ResCult has three main objectives being: *Improving the Disaster Risk Reduction Strategy* for cultural heritage buildings, increasing cooperation between EU member states in order to better protect Cultural Heritage and to bolster the capability of Civil Protection bodies to better respond to threats to Cultural heritage sites.

Museo del Risparmio

Address: via S.Francesco d'Assisi, 8A - Torino

Website: <http://www.museodelrisparmio.it/>

Visited: Wednesday 24 October

Founded by Piedmontese Bank Intesa San Paola, the “Museo del Risparmio” is an interactive and entertaining museum where visitors are able to deepen their understanding of aspects and concepts related to the issues of savings, money and investment. In a pre-visit interview with the museum curator, Ms. Giovanna Paladino, an outline of the concept behind this museum was explained. “Museo del Risparmio” is not the traditional museum, but more of an Edutainment project. Ms. Paladino, who holds a PHD in economics and finance explained that a very deep understanding of the subject was curtail for the museum’s success. As a curator she was also aware that the topics of numismatics and finance can be quite boring and technology and interactivity were used to engage and surprise visitors.

The Museum’s mission is to contribute to spreading FINANCIAL EDUCATION to help people make rational and informed decisions and act in ways to achieve the priorities of their lives.

(Mission statement Museo del Risparmio <http://www.museodelrisparmio.it/idea/>)

This goal is achieved through the effective use of Edutainment using a variety of digital tools within the museum and via the web. The content design is aimed at a variety of audiences including children, teenagers and adults.

The museum visit starts with an introduction to the history of money, fiduciary loans, the origins of banking operations, speculative bubbles and principle financial instruments such as derivatives, shares and investment funds. Complex topics are explained using a variety of animations, docu-fictions, interviews and movie clips. The museum uses animated characters as the museum's mascots (For and Mika) but also to explain concepts in animations. The final effect is that the video clips are fun and light to watch by all types of visitors.

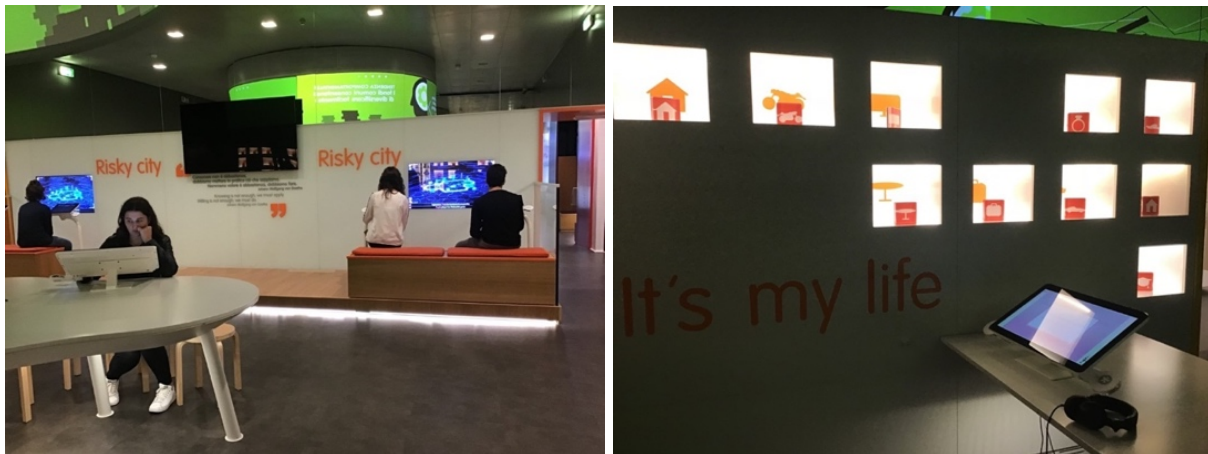
The topic of finance and money is also mixed and explained through literature and cinema. Holograms of Dante, Hemmingway, Shakespeare and Molièr speak as well as various cinema directors speak about how they dealt with money in their works.

Gamification has been extensively used within this museum to help users understand and learn concepts related to finance. This museum is an excellent example of how the use of video games and apps can help to engage visitors in the museum experience. The system keeps track of the visitors' skills, performance and understanding of financial concepts and tools.



Photos showing the use of digital signage and embedded media looping with a hand held audio speaker to play a series of cartoons to explain in a very easy way important complex financial concepts.

Source: Taken by myself.



Photos showing the use of interactive computer technology used throughout the museum. Visitors are encouraged to explore and engage with this technology through the use of gamification.

Source: Taken by myself.



Photos showing the use of directional audio which was very effectively used throughout the museum to implement a large number of sound enabled presentations in close proximity without creating sound / noise interference.

Source: Taken by myself.

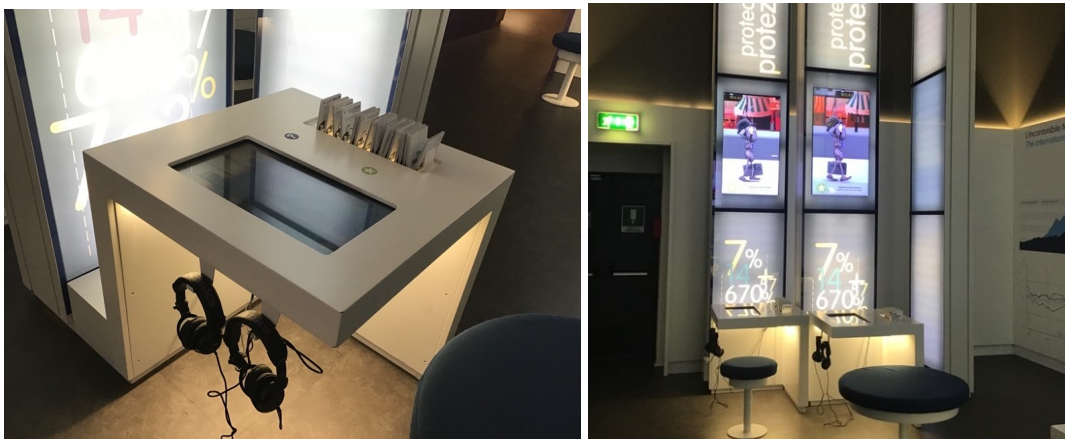


Photo showing interactive units using RFid technology. Users to interact with different information units using the touch screen. Specific content could be loaded onto the unit by touching an RFid powered tag onto the unit.

Source: Taken by myself.



Photos showing the intelligent use of LCD screens to give the impression of a hologram effect. These “holograms” were used in the section linking literature and money. Directional audio was used to allow multiple writer holograms to be active within the same area and not have sound interference.

Source: Taken by myself.



Photos showing the experiment zone, the penultimate room in the museum. It encourages the visitor to play a number of games and win points for a final ranking all recorded via the RFID access card given to the visitor upon entry to the museum. The main aim of the games is for the user to learn how to manage money balancing between risks and profits.

Source: Taken by myself.

Uffizi

Address: Piazzale degli Uffizi, 6, 50122 Firenze FI, Italy

Website: <https://www.uffizi.it/gli-uffizi>

The world-famous Uffizi galleries hold a priceless collection of works of arts commissioned or purchased by the powerful Medici Family. This is one of the most important museums in the world visited by thousands of visitors every day. To avoid queuing for entrance into the museum I purchased the entry tickets in advance and was at the entrance before opening time. Entrance to the museum is highly organised and even though there were many visitors, traffic flow was organised and flowing. It was immediately clear that huge art galleries such as the Uffizi require their own specific methods of interpretation as they have their own specific challenges.

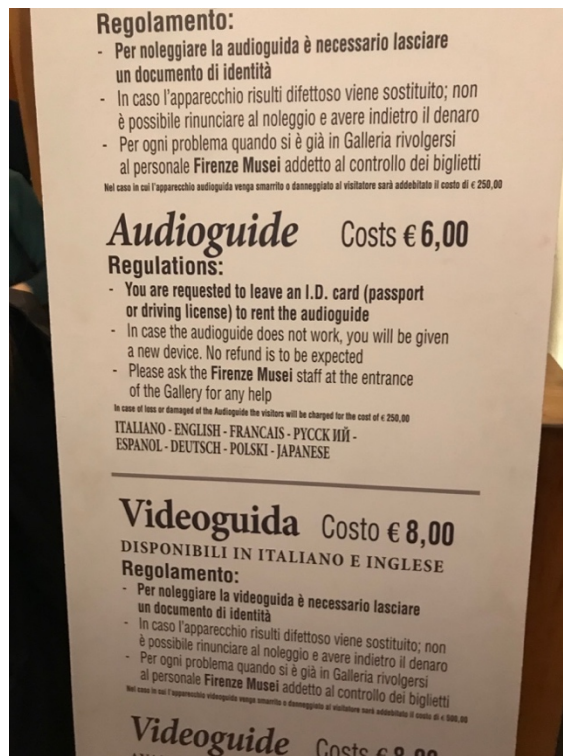
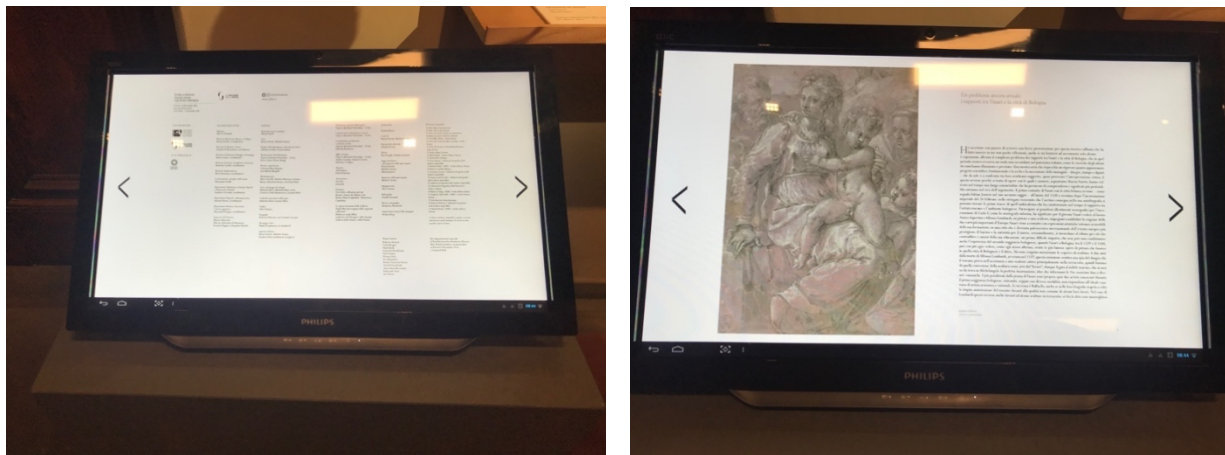


Photo showing the audio-guide used at the Uffizi. A video-guide was also available at a slightly higher price. I decided to go for the audio guide since this was the unit being rented by the absolute majority of visitors.

The Uffizi audio-guide was an old style RSF PortaDap Basic unit. Content was available in eight different languages (Italian, English, French, Russian, Spanish, German Polish and Japanese). Users could obtain information about specific paintings by keying in the corresponding number next to the painting. The Narration style of the descriptive content was quite technical with very little, if any, story background for putting painting into context. I noticed that it was not always easy to find audio guide numbers next to exhibits - due to the huge number of exhibits, crowds of visitors and not always clear signage.



Photos of the interpretative touch screen used to explain some of the paintings on display. The content design lacked any consideration for the medium on which it was being displayed and the users' requirements. Navigation was too basic, the amount of text too long and the font size too small making it very difficult, too long and too boring to read from a standing up position. Source: Taken by myself.

There were no other digital tools apart from one touch screen which seemed to show some PDF document which was too small to read. This led me to think that very large and extremely popular museums do not feel the need to invest in the visitor experience simply because they are always full up of visitors wanting to get in.

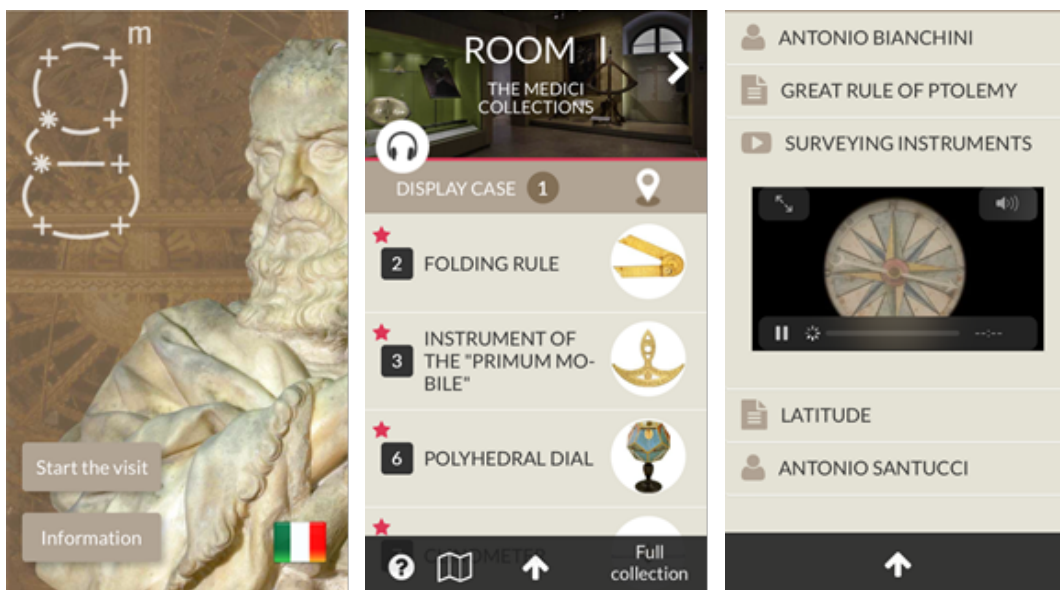
Galileo Museum

Address: Piazza dei Giudici 1 · 50122 Firenze · ITALIA

Website: <https://www.museogalileo.it/en/>

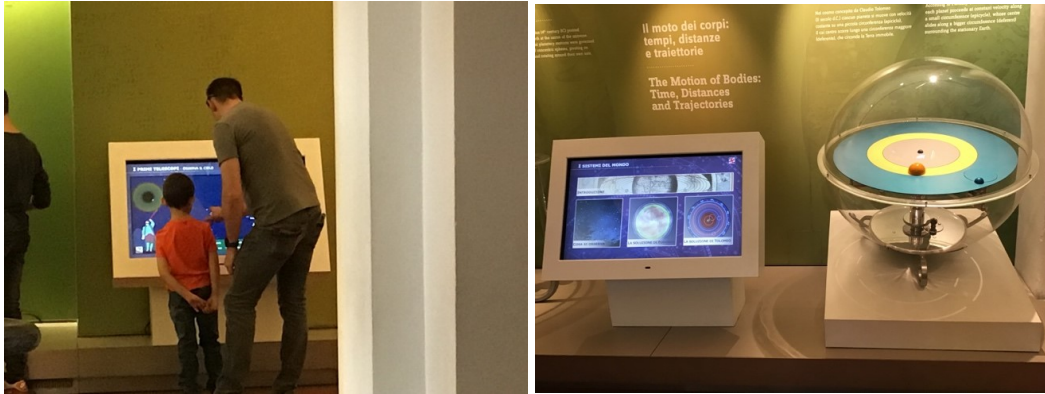
The Museo Galileo is located in an 11th century building, in Piazza dei Giudici close to the Uffizi Gallery. The huge collection of scientific instruments related to time measurement, astrology, navigation and scientific investigation is evidence of the importance that the Medici and Lorraine rulers gave to science and scientists. The museum, formerly known as “The Museo di Storia della Scienza”, opened in 2010 after a complete redesign.

When planning my visit to this museum, I found out that the museum website offered two very useful digital tools. The first was a downloadable app, and the second was a virtual museum full of information about the artefacts on display at the museum.



Screenshots from the Museum App which doubles up as an audio guide. Visitors to the museum can connect to the free wifi service to download the app, and access any downloadable information from the virtual museum.

Source: Taken by myself.



Photos showing the activity room on the ground floor of the museum offered a number of hands on activities and experiments to demonstrate some of the discoveries and concepts showcased by the museum. This area used touch screen systems to allow visitors to find out information about the experiments they were about to try. This area was very popular with children which were keen to try out the different experiments.

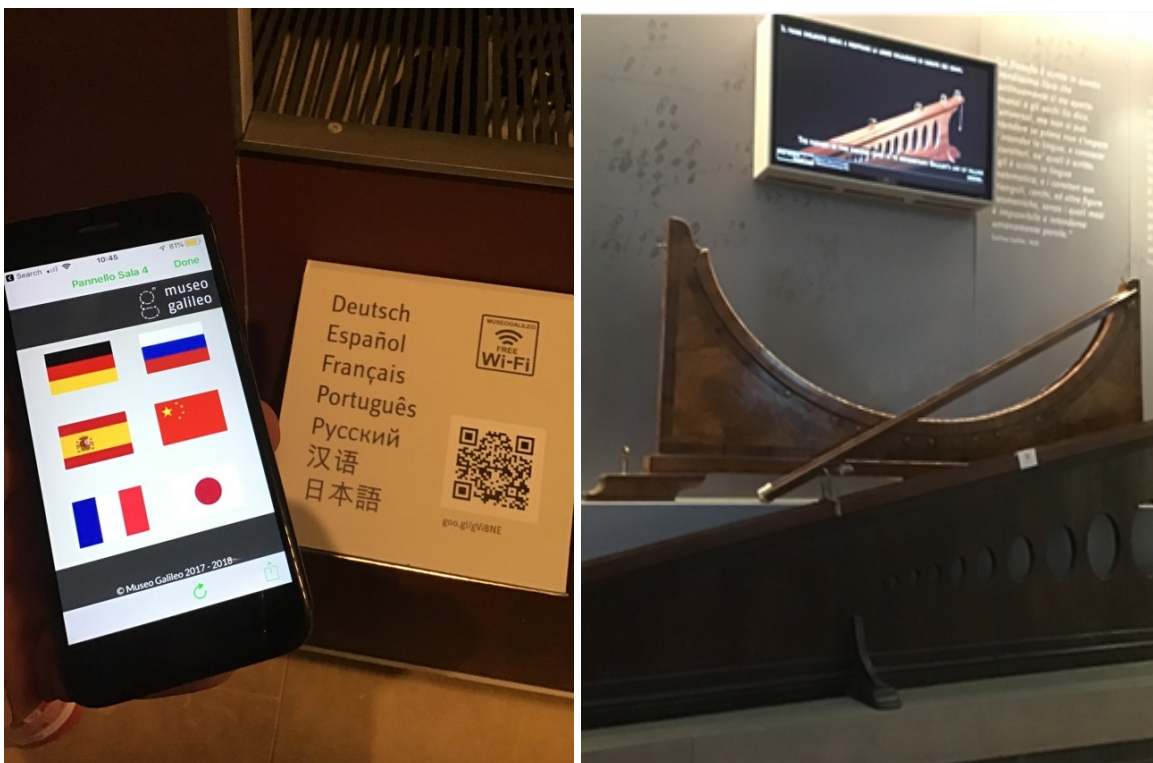


Photo showing the app being used to access multilingual information about some of the artefacts via QR code scanning. Additional artefact info was made available through digital signage screens showing movies or animations installed close to the artefact.
Source: Taken by myself.

The Virtual Museum

The museum has an official virtual version of the physical museum, presenting information on more than one thousand artefacts on permanent display at the museum (<https://catalogo.museogalileo.it/>). Biographical info and in-dept charts are used to place the objects into context, whilst animations and movies are used to explain more complex objects. The virtual museum allows the visitor to explore the whole museum without even physically setting foot into it.



Screenshot showing the main landing page of the virtual museum (<https://catalogo.museogalileo.it/>) offering links to the main sections of the museum.

Virtual tours

There are two main collections – the Medici collection and the Lorraine Collection. One can find detailed information about the different 16 areas/rooms within the museum. Each room has a video explanation, which can even be downloaded as a video or audio and used as a guide whilst visiting the museum. Detailed information about the artefacts in each room can also be found.

The screenshot displays the 'VirtualMuseum' interface for 'Room X: The Lorraine Collections'. The top navigation bar includes the 'museo galileo' logo, the title 'VirtualMuseum', and 'Room X The Lorraine Collections'. Below the title, there are social media icons and a link to 'Index of rooms'. A video player is the central focus, showing a 3D virtual tour of a museum room with various scientific instruments. The video player includes a play button, a progress bar (0:00 / 1:33), and volume controls. To the right of the video player, there are links for 'Download video' and 'Download audio'. Below the video player, a 'Sections' section lists four categories of artifacts:

- Physics and Optics Instrumentation**: The Museum cabinet of physics was constantly updated with mechanical and pneumatical apparatus, electrostatic machines and measuring devices. Numerous ... (31 objects)
- Meteorology and the Museum Workshops**: The Museum of Physics and Natural History devoted major resources to research in meteorology and its instruments. In 1839 the Director, Vincenzo Antinori ... (6 objects)
- Peter Leopold's Chemistry Cabinet**: The so-called "chemistry cabinet" formed part of the private laboratory ordered by the Grand Duke, who left it to the Museum of Physics and Natural History ...
- Medical science**: The Lorraines' interest in medicine is documented by some exceptional artifacts, of which a selection is on display. The 40 clay obstetrical models were ...

Screenshot showing the individual room info. The video introduction gives an overview of the room, its context and the artefacts that can be found here. Artefacts are grouped by topic/sections.

Source: Taken by myself.

The screenshot displays the 'VirtualMuseum' interface for the 'Air pump, twin barrels, table-top model'. The page includes a search bar, social media icons, and a breadcrumb trail: Home > Room Index > Room X, The Lorraine Collections > Physics and Optics Instrumentation > Section of Room X. The main content area features a metadata table, a photograph of the air pump, and a detailed text description. A right-hand sidebar contains categorized lists for Provenance, Related people, Typology, Context, Dictionary, and In depth.

Setting:	Room X
Maker:	unknown
Place:	Paris
Date:	ca. 1830
Materials:	mahogany, brass, iron, glass
Dimensions:	total height 520 mm, base 460x400 mm
Inventory:	3777

Typical nineteenth-century French air pump, fairly common in physics laboratories until the early twentieth century. Mounted on a wooden base, it is fitted with two glass barrels whose pistons carry racks and are operated by a pinion with two handles. The mechanism is housed in a frame supported by a pair of small brass pillars. A stop-cock at the base of the barrels regulates the flow of air from the bell-jar, which rests on a metal plate covered by a ground-glass disk. In 1827, the Italian physicist Giuseppe Belli invented a special faucet for adjusting the connections between the pistons and the plate so as to obtain a better vacuum. This device was reinvented independently a few years later by Jacques Babinet, whose name is engraved on the faucet. A mercury pressure-gauge or manometer fitted with a second faucet is screwed onto the connection between the plate and the barrels. English-made pumps of this type always had brass barrels, while those made in France generally had glass barrels. Provenance: Lorraine collections.

- Provenance**
 - Lorraine collections
- Related people**
 - Jacques Babinet
 - Giuseppe Belli
- Typology**
 - Air pump
- Context**
 - Air pump
 - Collecting tradition of the House of Lorraine
 - Pneumatics
- Dictionary**
 - Pressure gauge or manometer
 - Rack
 - Rackwork
- In depth**
 - Mercury
 - Vacuum

Screenshot from virtual museum showing detailed artefact explanation of the artefact.

Source: Taken by myself.

Biographies

The virtual museum contains a complete database of all the biographies of inventors and constructors linked to the collections and artefacts found at the museum.

Artefacts Database

The virtual museum contains entries for every single artefact forming part of the permanent collection. Each entry has a short explanation about the artefact as well as information related to

the artefacts including location and inventory details, manufacturer, date, materials used and the dimensions of the artefact.

Video Database

A significant collection of videos and animations can be found in the virtual museum. These videos are grouped under 16 different categories being: Academies and Institutions, Astronomy, Chemistry and Pharmacy, Scientific collecting, Electricity and Magnetism, Galileo, Geography and Cartography, Mechanics, Medicine and Biology, Meteorology, Measurement of time, Measurement of space, Optics, Pneumatic, Calculation tools and Drawing tools. The use of video and animations makes it very easy for the visitor to understand sometimes complex concepts and ideas. Each of these video clips could be downloaded as a video or audio. Free WIFI throughout the museum allows the user to view any of these clips whilst visiting the museum itself. Being web based, all this content can be viewed off-site.

Museum Catalogue

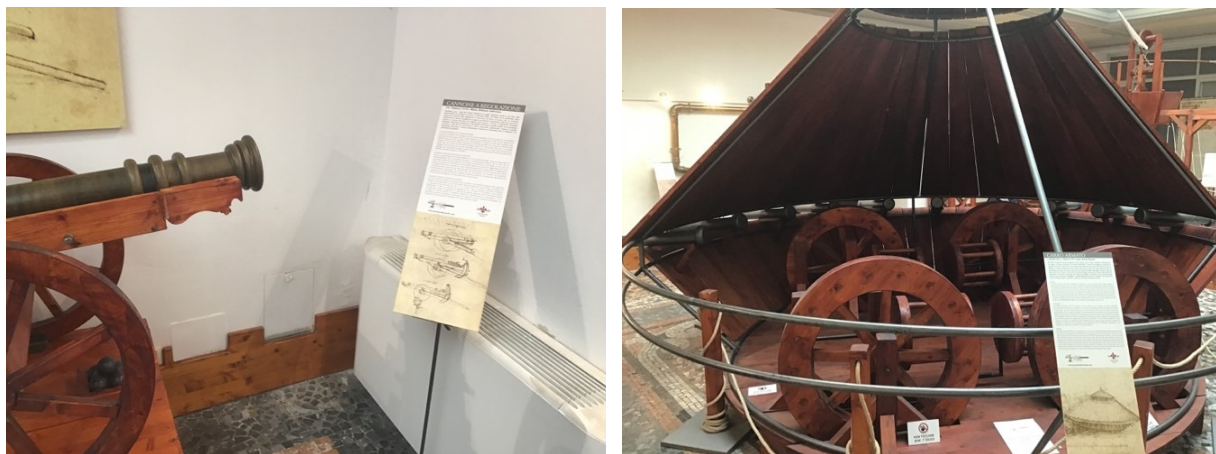
The complete Museum catalogue can be downloaded as a PDF file. The full colour catalogue contains information about every single artefact on display at the museum. Like the information on the website the catalogue is available in English or Italian.

Leonardo Da Vinci Museum

Address: Via Cavour 21 Florence 055-295264

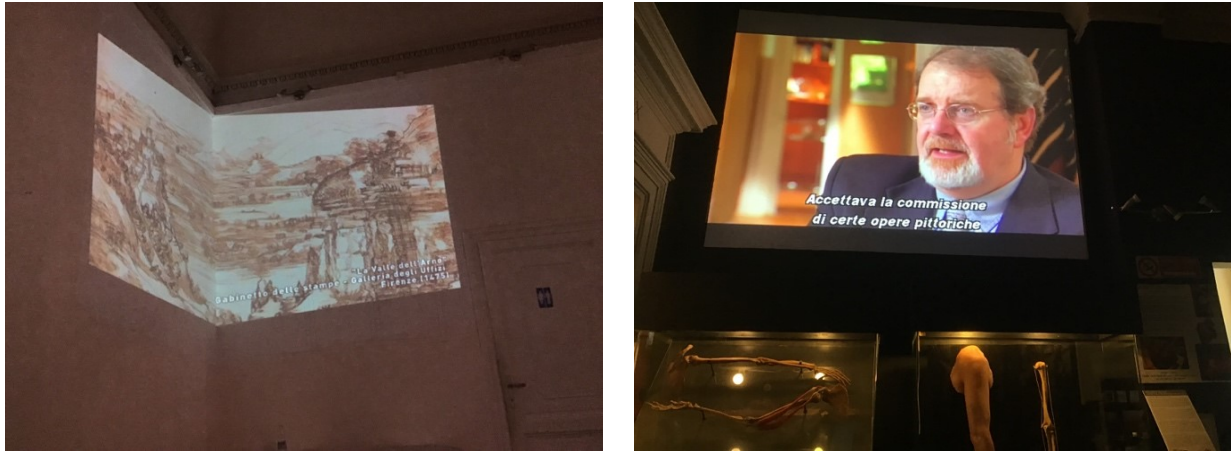
Website: <http://www.museoleonardodavincifirenze.com/>

One of two museums dedicated to Leonardo Da Vinci's creations in the city of Florence. The museum's website claims that this is "the largest (PRIVATE) collection of Leonardo da Vinci machines" worldwide (Museo Leonard da Vinci, 2017). The collection started in 1936, now boasts around 250 models of Leonard's inventions. The "museum" is spread over four rooms on the ground floor of a building in central Florence.



Photos showing large scale models of Leonardo's drawings and inventions. The only information available were some static information signs with very basic information.

Each of the machines exhibited has an information board next to it giving a brief explanation of the invention or technology used in Italian and English. Visitors can touch and operate a good number of the exhibits. This is the main attraction of the museum, the ability to operate and experiment with the objects on display.



Photos showing the low-quality documentary projections were the only form of digital tools available in this museum. The actual content in these projections was not very suited for a museum environment as it was way too long as an introductory documentary.
Source: Taken by myself.

The use of digital tools in this museum is limited only to projections. There are two rooms with projections. One shows a series of images related to Leonardo in the form of projects. The user does not get any information about what is being displayed as there is no voiceover or captioning. In the room dedicated to the anatomical models there is a projection showing a looping documentary about Leonardo. The documentary is quite interesting but it is way too long for a museum display. The documentary is 90minutes long. The length of the video meant that most people did not watch the full documentary or used the seating area as a resting place without really giving attention to the video being played.



Photo showing the small educational corner within the museum. This offered some basic hands on activities for children. The lack of clear instructions and manuals accompanying these activities meant that children were just moving from one game to another without really understanding what they had to accomplish.

Source: Taken by myself.

In one corner of the room is an educational area for children, this is nothing more than a basic colouring area and a few more models to try out. Children in the room were moving around from one model to another trying things out but not so sure if they were really understanding what they were doing. Unless visitors spent the whole 90 minutes watching the documentary the visit is very short, less than one hour. Information available is not well presented and the museum displays hold much less models than the claimed 250 on the official site. Interesting scientific concepts are not interestingly illustrated, no touch screens or animations allow the user

to understand what the model is actually demonstrating. The museum shop is also very basic and not presented in an interesting way. Very few visitors stopped to check out what was on display.

Just like the museum its website is very old and dated. It is not mobile responsive and offers very basic information about the visitor experience itself. It does not allow for online shopping of tickets and does not offer any downloadable information or app. This should have given a very good indication of the quality of the museum itself.

APP3.5.3 Museum Name: Train World

Address: Place Princesse Elisabeth 5, 1030 Bruxelles, Belgium

Website: <http://www.trainworld.be>

Visit Date: January 2019

Train World is a historical museum showcasing the history of the Belgian Railways.

The museum traces the development of the rail way in Belgium since the first train, which went into service since May 5th 1835. As pioneer of train transport, Belgium has a rich railway heritage as can be amply demonstrated in this museum. In 1846, Brussels and Paris became the first two capitals in the world to be connected by rail, and over the next century Belgium built more than 16,000 locomotives, exporting 10,000 of these. The museum highlights the technological advances in railways, the move from steam and coal to diesel and to electric. Train World includes a fantastic collection of railway memorabilia, locomotives, carriages, and different technological tools used for train travel, ticketing, signaling and management.

Train world is much more than just a collection of artefacts and memorabilia relating to Belgian railways. The human aspect related to the train industry, train travel, socio-economic development, identity, history and employment are some of the topics treated by the exhibits. The museum itself is located in a beautifully restored typical nineteenth century railway station at Schaerbeek. The building is in itself a museum capturing the feeling of train travel in time. It further helps put all the exhibits into context especially the human context.

To enter the museum, you need to buy a train type ticket from the old box office, the ticket is then validated to allow you entrance. The eye to detail, designed at making the visit attractive even for younger visitors makes it a very fun type of visit. Indeed, children have a wide variety of exhibits targeted at catching their attention from a large fully functioning Lego railway set to various Lego characters included in the different displays.

Employment in the railway industry. The human aspect of employment can be seen throughout the whole museum. As visitors are encouraged to explore the different locomotives, they can hear via the audio guide or app recordings of experiences of railway men manning the locomotives, of their daily experiences and their life on the trains. The life of railway people is immortalized in the railway house integrated into the museum itself. Here the railway master lived on site 24/7, and visitors can visually imagine life in the railway master's house as furnished in 1950's decor. Again, here visitors can hear Guido, son of the last railway master, recount his experience as his family moved into the house at the height of the second world war. Employment on the railways was often passed from father to son and the safety of manning the railway crossings was often entrusted to the wives of track workers.

The museum does not shy away from difficult subjects such as how railways between July 1942 and September 1944 moved thousands of Jews and Gypsies to their death in extermination camps, in closed goods wagons. The story of how thousands of Belgian railway workers lost their lives trying to sabotage equipment, hiding escapees or passing information about train movements. One display shows a letter written by a railway worker to his family, written a day before being executed for disobeying and working against the Nazi occupiers. The audio guide experience makes this testimony even more chilling as visitors can here the letter's contents being read out.

The train Simulator – Towards the end of the museum visit, visitors could access two futuristic-looking train simulators built by Transurb Simulation. The simulators are intended to offer a fun way of discovering the train driving profession. Easy to use without the need of any specific training, the simulators take the train driver through the railways of the future, and allow the visitors to become completely immersed in the train driving activity. Their location as well as the futuristic design immediately captures the attention of visitors who waited patiently in queue for their turn at one of the simulators.



Photo showing the entrance ticket and the audio guide. The guide was available at an additional 2Eur cost to the entrance ticket, but visitors had the option to download the museum's app on their smart phone and have access to the same audio content available on the audio guide.

Source: Taken by myself.



Photo showing the "Railway Promenade" in the historic station at Shaerbeek, houses a collection of items historical related to the issuing to rail tickets, uniforms and railway employees. Large digital posters showed a series of looping images related to historical train posters as a form of trailer/teaser for visitors starting their journey within the museum. These as well as audio created a multi sensorial environment that helped the visitor immerse himself into a real train station not just a museum. The carefully studied design ensured that any modern digital tools fitted unobtrusively within the historical setting of the train station.

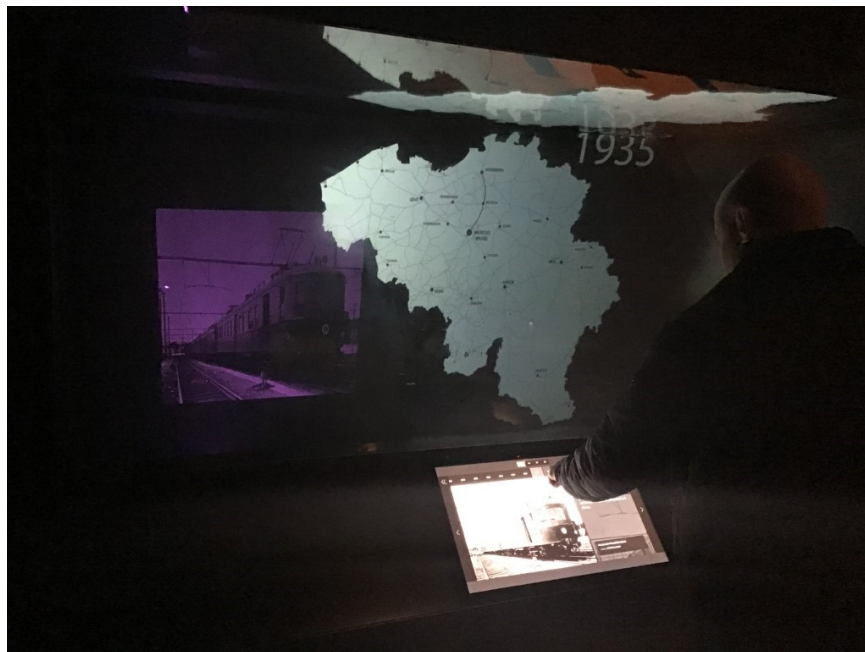


Photo showing an interesting installation combining touch screen and projection to create a type of interactive hologram to explain the development and expansion of the Belgian railway network.

Source: Taken by myself.



Atlantic Type 12 - Belgium 1938

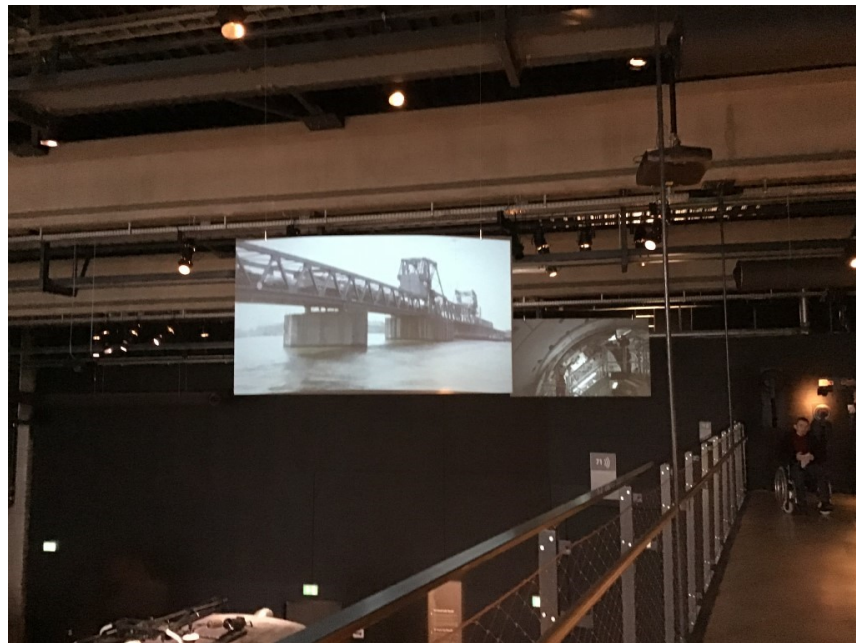
“Such beautiful lines, such elegance. I never tire of looking at her with her futuristic looks, she’s typical of the quest for modernism and speed which characterized the 1930s. Her aerodynamics and 2.1m wheels made her a champion of speed and beauty. She holds the blue ribbon record for the fastest steam train world record.... This locomotive resembles no other and looks like a plane on wheels and one could easily expect her to take off at any time” Source: Audio guide description for the Atlantic Type 12. The narration of content on the audio guide was powerfully descriptive and focused on story telling rather than just facts about trains.

Source: Taken by myself.



Photo showing the railway master's house was integrated into the museum and is decorated in 1950's furnishings. Large scale projections on the side of the house as well as the recordings on audio guide/app help visitors learn about the inhabitants of this house and their link to the railway.

Source: Taken by myself.



The museum makes extensive use of projections throughout its display setup. These help visitors understand easily the subject matter of the displays they are viewing as well as put them into a historical context.

Source: Taken by myself.



Photo showing the train simulator at Train world was probably the most sought after and popular exhibit with all the visitors in the museum. The use of digital and gamification was a big attraction for visitor engagement within the museum.

Source: Taken by myself.

APP3.5.4 Tombs of the Kings

Venue:	Tombs of the Kings,
Type:	Necropolis
Address	Paphos Archological Park
City	Paphos
Country	Cyprus
Admission	€ 3 - Adults
Date Visited	March 2019

The Archaeological Park of Kato Paphos contains most of an ancient Greek and Roman city located near Paphos. It has been a UNESCO World Heritage Site since 1980. Some of the most important finds in this park include four Roman villas best known for their very well-preserved floor mosaics. Other excavated buildings include an agora, a basilica, an odeion and a Hellenistic-Roman Theatre. The “Tombs of the Kings” is a large necropolis forming part of this archaeological park.

I chose to visit this site, as it's one of the top listed sites on the web for visits in Cyprus, particularly in Paphos. Many tourist tours are organised to this site by many operators making this one of the main tourist sites in Cyprus. These big tombs, dating back from Hellenistic and Roman periods, are carved out of solid rock.



Photos showing some of the rock hewn monumental tombs

Source: Taken by myself.

This large burial site dates back to the Hellenistic and Roman eras and is made up of large underground tombs hewn out of the solid rock. Although the area is called “Tombs of the Kings” it was actually high-ranking members of the aristocracy and officials that were buried here. Some of the monumental tombs are decorated with Doric Pillars carved out of the rocks.

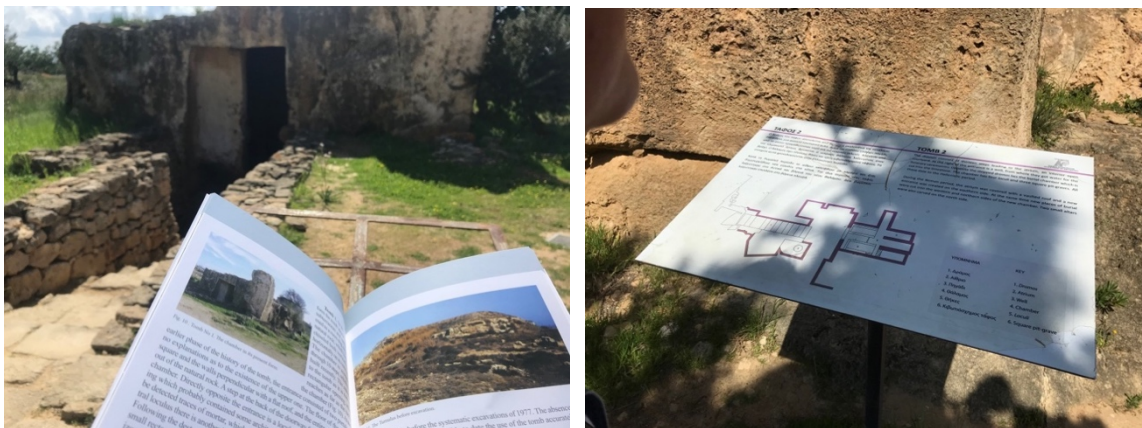
Some of the tombs are designed to imitate the houses of the living, complete with antechambers overlooking a central court yard and peristyle. These tombs are similar to one found in Alexandria, which show the strong links between the two cities during the period.



Photos of tombs designed to imitate real houses.

Source Taken by myself.

Like most of the sites in Cyprus, the entrance fee was extremely low but when I asked for audio guides, I was informed that none were available. I was instead offered to buy a guide book in English, which I bought, but which was too detailed to stay reading on site. The audio book had a map with marked tombs which was not too easy to follow. On site, signage was extremely limited with some of the few signs available being broken. There was no directional signage which made the visitor feel lost, or else which caused them to skip some parts of the trail completely. Whilst wandering around I met some other visitors from the UK and Cyprus. They all expressed the same feelings about the site. Whilst the tombs themselves were impressive, as was the size of the actual site, the lack of signage and information did not allow the visitor to understand what they were visiting. The lack of narrative, story line and historical context of the site meant that visitors could not really appreciate this important archaeological site. Apart from the ticket office receptionist there was one site officer going around but he did not speak any English and when I asked for directions, he could not understand me.



On-site signage is missing and limited, finding your way around the large site from one tomb to another was quite a challenge.

Source: Taken by myself.

APP3.5.5 Selimiye Camii

Venue:	Selimiye Camii
Type:	Religious Building
Address	Selimiye Sk,
City	Lefkoşa
Country	Cyprus
Admission	Free
Date Visited	March 2019

The Selimiye Camii mosque is found in the old city centre of Nicosia, currently under the occupying Turkish forces since 1074. With a capacity of 2,500 worshippers the Selimiye Mosque is the largest place of worship in Cyprus. The building was originally the Roman Catholic Cathedral of Saint Sophia, the biggest and oldest Gothic style church in Cyprus. It was then, in turn, built on the site of an earlier Byzantine church. This building's very interesting history includes the time it took to build the cathedral. Its first stone was laid in 1209 and consecrated in 1326 even though it was not completely finished. French masons were used to build the cathedral, which the ruling kings of the time wanted look like Notre Dame in Paris. To help speed up construction, the pope gave a 100-day indulgence for those working at the cathedral. It was converted into a mosque in 1571, when Cyprus was conquered by the Ottomans. Apart from the addition of the two minarets, various architectural changes were made, although the Gothic style of the building is still very evident.



Photo left Showing Selimiye Camii mosque formerly the Roman Catholic Cathedral of Saint Sophia.

Photo right: The only information sign about the building and its history was this small sign stuck on the outside of the building.

Source: Taken by myself.



Photos showing the inside of the mosque, to the trained eye one can see various architectural changes done to the building especially on the supporting columns. To the uninformed visitor the lack of interpretation and explanation of the site does not help the visitor understand the historical relevance of the building.

Source: Taken by myself.

There were a number of reasons why I wanted to visit this building. The mosque was listed on various websites as the top attraction to visit in Nicosia, making it the top tourist attraction apart from a place of worship. It was my first visit to a major cathedral converted to a mosque and not

the other way around. Being located in an occupied part of Cyprus I was curious to see if this would have any bearing on the interpretation and information communicated.

Unfortunately, all the information I listed above came from researched sources online and not from the site itself. There is absolutely no interpretation at all at this site. The unaware visitor has no idea of the building's history, how it was used, converted, reused and redecorated over the centuries. No didactic boards, audio guides or any digital tools were available, no guides or docents were available to explain anything to visitors. With absolutely no information available the visit to the mosque was a very short one indeed. I could observe the other few visitors having a quick look around, snapping a couple of photos and walking back out. I can see a huge difference when I compare this visit to the visit to Mosque – Cathedral of Cordoba, where the various information tools gave a much more complete picture and context to the visitor.

APP3.5.6 Church of Panagia d'Asinou

Venue:	Church of Panagia d'Asinou
Type:	Religious Building
Address	Troodos Mountains
City	[Lefkosia (Nicosia) district]
Country	Cyprus
Admission	Free
Date Visited	March 2019

The church of Panagia d'Asinou is a small medieval church dedicated to the Virgin of 'Phorbia' and is found around 3km away from the mountain village of Nikitari. The church has been listed as a UNESCO World Heritage Site. I missed the church whilst driving through the Troodos mountains, as I was somehow expecting a much bigger edifice. Once inside the church, I was blown away by the beautiful Byzantine paintings that cover every inch of the church's internal walls.

Built in 1099, the church served as the *katholico* (monastery church) for the Monastery of Forbion and remained operational till the 18th century after which it was abandoned. Two distinctive sections make up the church, the first is a vaulted single-aisled nave and the narthex added in the later part of the 12th century. Since then a steep-pitched, flat tiled, timber roof has covered the church. Today, apart from the church, there are no traces of the monastic buildings.



Photo showing the outside of the Church of Panagia Asinou.
Source: Taken by myself.



Photos showing the magnificent Byzantine Frescos decorating the inside of Panagia d'Asinou .
Source: Taken by myself.

The interior of the church is completely covered with beautiful, vivid and richly decorated paintings. The frescos, dating from 1105 onwards, reflect the art of Constantinople. These paintings are thought to be one of the most important examples of Byzantine art of the period. Most of the original paintings from 1105/6 are well preserved in the apse and west wall of the church, yet the church suffered damages mostly from earthquakes and in the 14th century, the conch in apse was rebuilt and redecorated after it collapsed.

The church has no signage, no interactive or digital interpretation tools. A very elderly man acts as custodian and opens the church daily and makes it very clear that photography inside the church is not allowed. Apart from that he understands and speaks no English. Unlike with the other heritage sites I visited, the reason for visiting this church was the result of my short time scientific visit to the Digital Heritage Research Lab at the University of technology in Cyprus. During my visit, Dr. Marinos Ioannides, UNESCO chair for Digital Heritage explained the various digital research projects which have been carried out on the church of Asinou in order to create a time machine which would allow researchers to understand how the church changed over the centuries.

The Digital Research Lab is interested in building an app to help visitors interpret the building and understand the narrative described in the frescos. The app is targeted towards different audiences, and tourist visitors would be interested in accessing different information from researchers. The app development would need to target the different audiences not only in the type and amount of information presented but also in the way it is presented and explained. Another consideration which needs to be taken when implementing the app is the fact of the low quality 4G data roaming in the area which would make it very difficult to download the app unless it has been downloaded before visiting the location.



Group photo with Dr. Marinos Ioannides, host of my STSM together with other researchers working on Church of Panagia, taken at the Cyprus University of Technology.
Source: Taken by myself.

APP3.5.7 Victoria and Albert Museum

Venue:	Victoria and Albert Museum
Type:	Museum
Address	Cornwall road
City	London
Country	UK
Admission	Free
Date Visited	May 2019

The Victoria and Albert museum's collections cover over 5000 years of creativity. Since its beginnings in 19th century, at the height of the Victorian period, the museum was intended to improve British industry standards through education in arts and science. Over the last 150 years the museum has constantly evolved and expanded its collections, establishing it as the world's leading museum of art and design. It is a great resource in the study of fashion, jewelry, photography, painting, furniture, architecture, textiles, sculpture, book arts, ceramics, theatre and performance.

The sheer size and variety of collections and exhibits would mean that reviewing in detail the Victoria and Albert museum would require weeks if not months. I have focused my research by spending a day in one of the best loved spaces within the V&A - the Jewellery hall.

The Jewellery collection can be found in rooms 91-93. Over 3,500 pieces of jewelry found in this collection make it one of the most comprehensive in the world. Covering roughly 3000 years of history, the collection includes jewels from ancient times to the present day. The hall

was redesigned in 2008 and has since then welcomed millions of visitors to the gallery. Every jewelry piece on display in this gallery tells a story of beauty, desire and envy.

The mind-blowin amount and beauty of priceless jewelry on display make this one of the most amazing halls that I've ever visited.

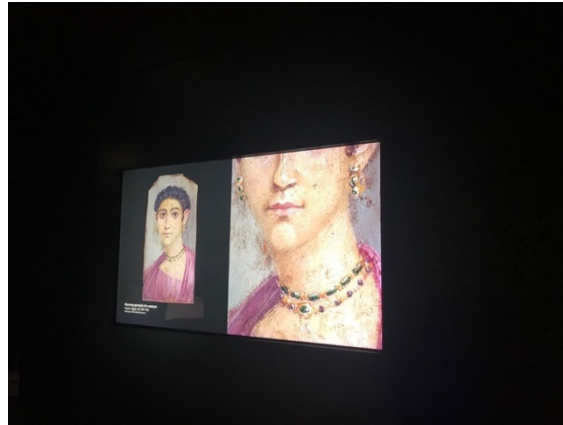
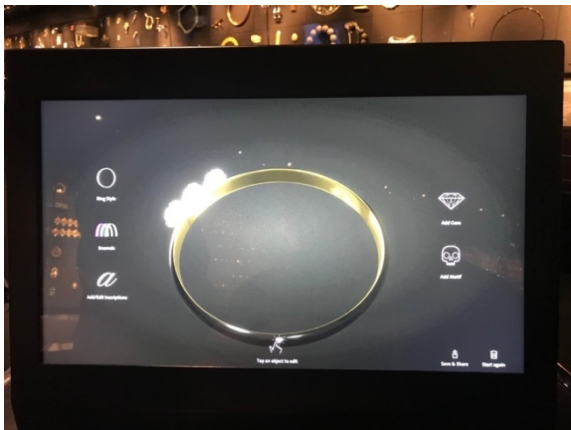
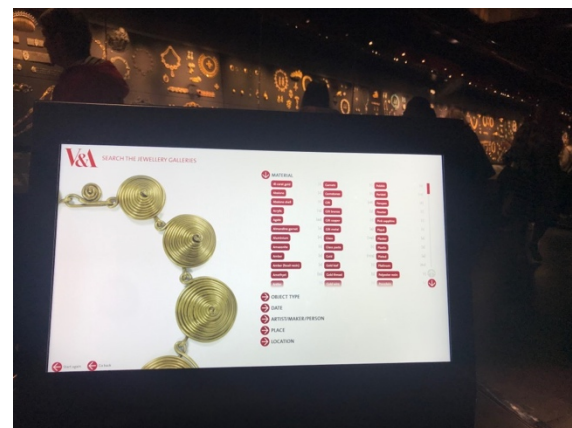
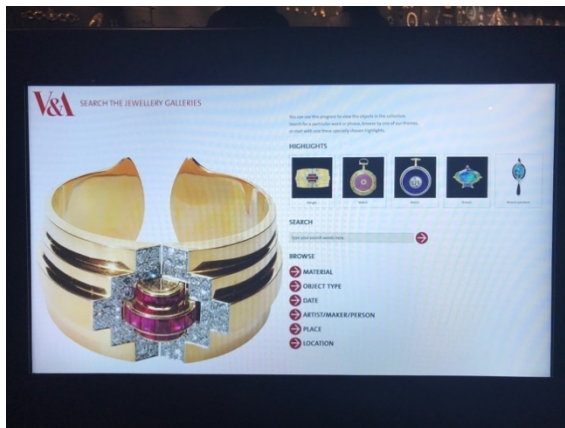
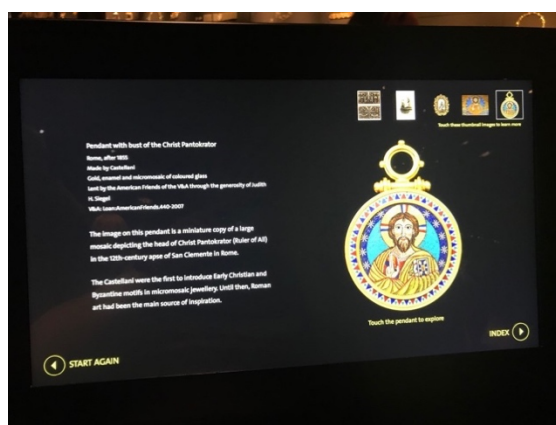
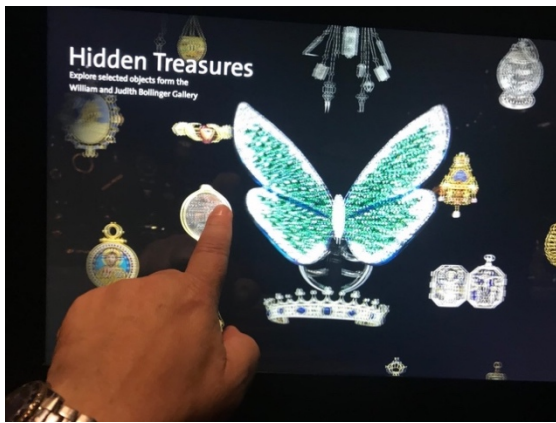


Photo left – one of the display cases within the Jewelry collection hall.

Photo right digital signage is used to showcase stories related to some of the exhibits or themes. This approach makes the display attractive also to people who might not be too excited with looking at thousands of items of jewelry on display.





The above eight photos show screen shots from the interactive touch screens used by visitors to access the full database of jewelry items within the collection. Navigation and displayed information made accessing the database interesting for all visitors. Source: Taken by myself.

APP3.5.8 British Library

Venue:	British Library
Type:	Library
Address	96 Euston Rd,
City	London
Country	UK
Admission	Free
Date Visited	May 2019

The British Library contains more than 200 million items making it the world's largest national library. As a major research library, items found within it are different formats both print and digital. Its oldest items date back to 2000 BC, and an estimated 3 million items are added to its collections every year. Before 1973, the British library was part of the British museum. The British library continually Displays a number of temporary and permanent exhibitions covering a wide variety of topics.

Imaginary Cities Exhibition (temporary exhibit 5 Apr 2019 - 14 Jul 201) - The “Imaginary Cities” exhibition was the result of the digitalization of more than 65,000 19th century books that were digitized with funding from Microsoft. These books are now freely available to the public. In 2013, the British library, supported by the Andrew W. Mellon Foundation and in collaboration with the Digital Scholarship Department, used novel

computational methods to allow the extraction of maps, illustrations and photographs from the pages of these digitized books. The result was an enormous archive of the more than 1,000,000 images, giving a unique and never seen before view of the 19th century. These images can be found on Flickr Commons, where digital volunteers can contribute to their curation through tagging and sharing.



Photos showing one of the artworks of “Imaginary Cities” using Virtual Reality to experience fictional futuristic cityscapes.
Source; Taken by myself.

“Imaginary Cities” encourages visitors to discover how digital tools are changing the future of collections. The digital installation, by artist in residence Michael Takeo Magruder, showcases fictional futuristic cityscapes or the information age. The work explores how digitized cultural material can in turn create its own digital artefacts in real time experiences. The four technology-based artworks are exclusively created from the images and meta data from 19th century city maps. Each piece combines the use of cutting-edge digital tools and traditional analogue processes. The artworks are shown alongside maps from the library’s digital archive as well as original source books. “Imaginary Cities” demonstrates how the library is not just a storehouse of knowledge but offers a dynamic and creative venue aimed at continuously offering new opportunities for culture.

“Treasures of the British library” - permanent exhibition gallery

A permanent exhibition covering some of the most exciting and significant items found within the British library. Through the “Sir John Ritblat Treasures of the British Library Gallery”, visitors can get a taste of the wonderful treasures found within the library. The large variety of unique documents, including Leonardo Da Vinci's notebook, original music scores written by Beethoven, Handel and Chopin, the original handwritten lyrics by The Beatles, beautifully decorated religious texts and works by masters like Dickens and Austen are just a few of the fantastic documents on display. The incredibly vast range of priceless documents on display is truly unique, covering all imaginable themes including science, literature, music, religion war, personal diaries and much more.

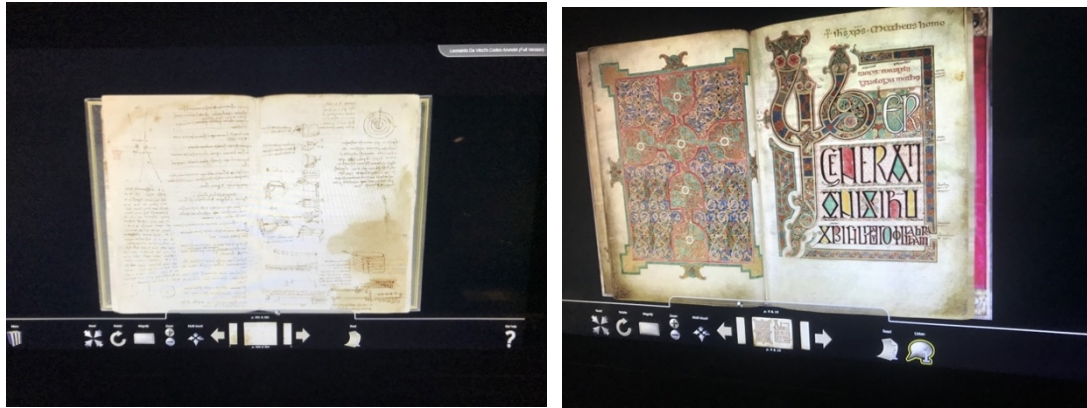


Photos showing the original Magna Carta and tablet-based displays allowing visitors to read and hear more about this unique document.

Source: Taken by myself.

The original Magna Carta is also on display in a specially fitted room using iPads to allow visitors to discover this unique document. A number of leading experts speak about

different aspects relating to the origin, legacy and context of this important historic document. In order not to disturb other library users, visitors using the interactive units wear headphones to listen to the videos on display.



Photos of the interactive touch screen units showing some of the rare documents on display. Users could use the screens to flip through these digital documents without ever touching the originals.

Source: Taken by myself.

Digital interactive units, situated next to the display units, allow visitors to explore some of the documents on display, being able to flip through the individual pages without touching the original documents. Visitors can also zoom in and rotate pages allowing them to examine each page in great detail. Most of the visitors in the gallery spent time on these interactive units exploring the different digitized documents on display.

APP3.5.9 Cathedral of Saint Mary of the See

Venue: Cathedral of Saint Mary of the See

Location: Seville

Date: Feb 2019

The Roman Catholic Cathedral of Seville (Cathedral of Saint Mary of the See) is the largest Gothic cathedral in the world and the third largest church in the world. This venue was declared a UNESCO heritage site in 1987. The enormous building occupies 23,500 sqm. Apart from the important religious significance of this cathedral it is also closely linked to Spanish history. Many important Spanish figures can be found buried here, including monarchs such as Ferdinand III, Alfonso the wise and important cardinals such as Juan de Cervantes and Pedro González de Medoza as well as the majestic tomb of the famous explorer Christopher Columbus and his son Diego Columbus.

The cathedral is built on the site of the Almohad mosque, built in 1172AD. A minaret was built next to the mosque and the building also included an ablutions courtyard. When Ferdinand III conquered Seville the mosque was turned into the city's cathedral. The current cathedral was built as a show of the city's trading power and wealth. Various elements from the previous mosque were retained, such as the mosque's sahn, which can be found in the orange garden. The old minaret was also retained and became the cathedral's bell tower now known as La Giralda and has come to symbolize the city of Seville.

Access to the Cathedral is against a fee. The entrance fee does not include an audio guide, but this can be purchased separately for a minimal fee. More than half of the visitors purchasing

tickets acquired an audio guide, which could be used within the cathedral, the orange garden and the bell tower. The audio guide itself was a very simple device. As the user moves along the cathedral, he/she would key in the number related to that particular location or artefact and listen to the related narration. Signage was generally easy to follow, most of the important locations or exhibits had prominently placed signs explaining the location and displaying the audio guide number. I noticed that people holding audio guides spent a much longer time inside the cathedral than those without. Even though didactic text bars were available, people without audio guides would generally move on quite quickly, most of them not bothering to read them. On the other hand, visitors with audio guides would sit down on a few pews, listen to the guide, and spend time admiring what they would have just listened about.



Photo Right: Audio guide used within the cathedral and La Giralda.
 Photo Left: Example of didactic board with Audio guide numbering.
 Source: Taken by myself

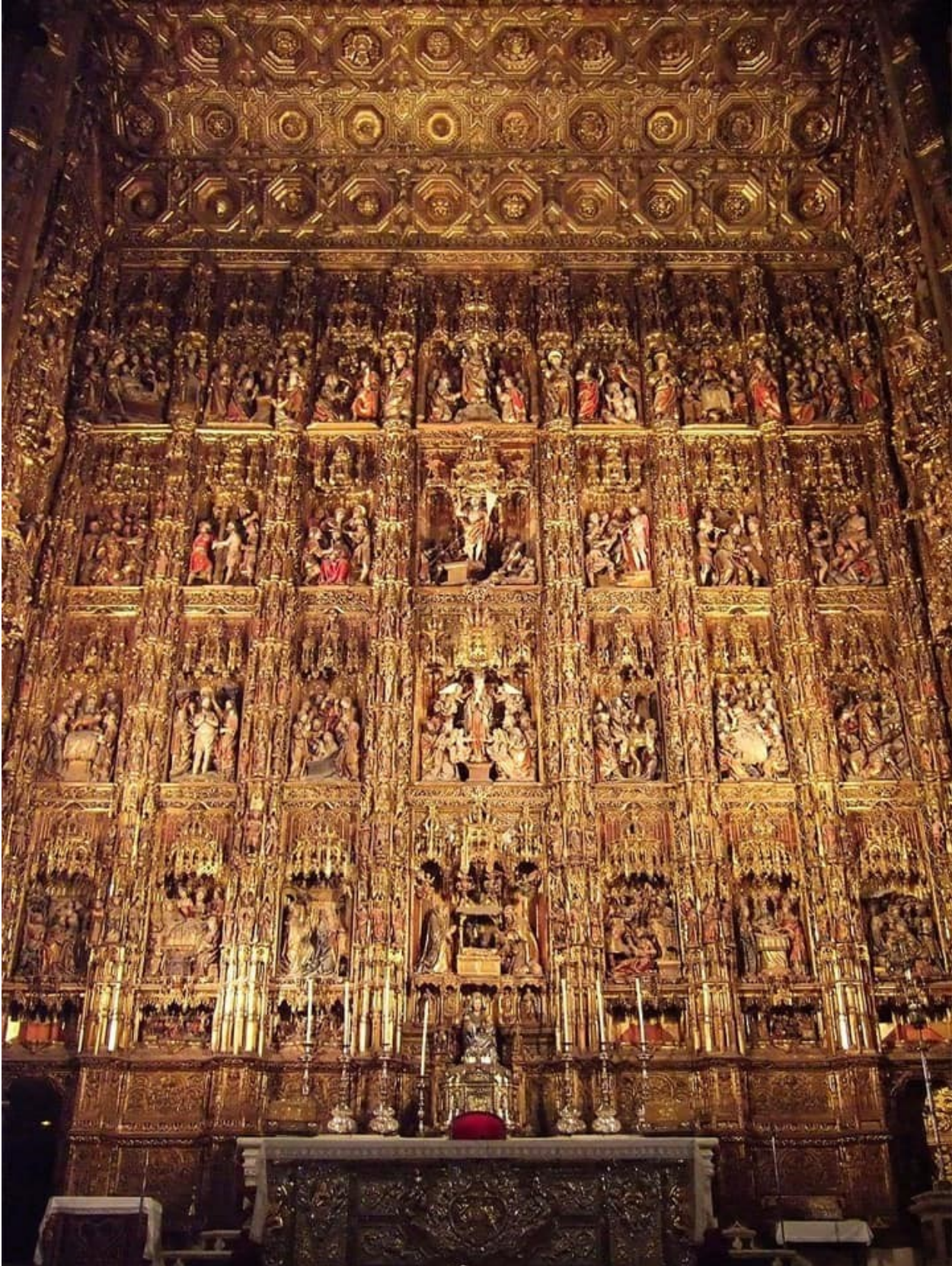


Photo showing the magnificent Retablo Mayor by Pierre Dancart. A timed light show sequence helps visitors appreciate better this huge altarpiece covered in gold gilded sculptures, narrating different biblical stories.

Source: Taken by myself.

The golden Retablo Mayor or main altarpiece is the most spectacular section in the cathedral. This magnificent work of art was created by the Flemish Artist Pierre Dancart over the course of forty-five years. The altar piece is separated from the public by large wrought iron grills. This altar piece is truly magnificent, it is the largest of its kind in the world. All those who visit the cathedral stop in front of the altar piece to admire it. Yet, without additional interpretation most visitors would not understand the symbolism and meaning of the altarpiece. This is where the audio guide comes in useful. Apart from describing the history and artist behind the Retablo Mayor, the audio guide explains the meaning of the thirty-six gilded relief panels. Each of these panels shows a story from the old testament or about the life of different saints. The small statue in front of this impressive wall of gold is that of Santa Maria de la Sede, to whom the cathedral is dedicated. Visitors not in possession of the audio guide could stop and admire the beautiful golden altar piece but would not have been able to understand its meaning. I also noticed that visitors without audio guides would spend much less time in front of the artefact before moving on.

Visitors in possession of audio guides could also take the units with them to the orange garden as well as to the bell tower. Again, I noticed users with audio guides were taking much longer to move around as they spent more time listening to the audio guide and observing the place that had just been described. Climbing the bell tower was quite a challenge since visitors had to walk 40 levels up to the converted minaret top hosting a large number of bells. Without the

explanation of the audio guide, there was no other information to explain the history of the bell tower and how it changed from minaret to bell tower over time.

The quality of content on the audio guide was very good, the narration did not simply describe the location or artefact but tied this to a story, putting that information into context. Sound effects and music helped make the audio playback even more interesting. Explanation was simple and clear to be able to be understood by any visitor.

Facilities for visitors were adequate: ample toilet facilities, rest areas, wayfinding and signage were available throughout the cathedral.

APP 3.5.10 Museum: Roman Baths

Address: Stall St, Bath BA1 1LZ, UK

Website: www.romanbaths.co.uk/

The Roman Baths found in the centre of the City of Bath in Somerset, are one of the best preserved ancient Roman era religious spas. These baths are made even more unique by the use of natural warm water flowing from Bath's thermal springs. Visitors to this unique Roman site will be able to experience first-hand a religious spa, dating from the 1st to the 4th century AD, where Romans could come to socialize, relax, get healed and pray.



Photo taken in the inside of the Roman baths showing the main baths still feed with the warm geothermal water.

Source: Taken by myself.

With more than one million visitors per year, this historic site is one of the most popular in the United Kingdom. The site has undergone major redevelopment to improve the visitor experience and ensure that the site is well preserved for the generations to come.



Photo showing the audio guide used within the Roman Baths complex. The content provided was very interesting full of storytelling targeted at all sorts of visitors.

Source Taken by myself.

It is very clear that the whole visitor experience has put children as one of the main target audiences. Various resources and activities are targeted at children. The website has a number of online games, including one where visitors can create their own Roman coin and save it in the site's virtual hoard. Another game teaches Roman numerals in a form of online

bingo, whereas visitors can find out which Roman Goddess they can identify with by answering a quiz.

Each entry ticket entitles visitors to the use of an audio guide and free guided tours are available every hour. The multimedia audioguide had two different settings one tour for adults and a tour for children. The adult guide is available in 12 different languages whereas the one for children is available in English, French and German. The narration used in the audio guide included music and special effects in the background to give a dramatization effect to the story telling. Apart from describing the artefacts the narration helps the visitor “see” these artefacts in context. Visitors are encouraged to imagine how the baths and the temple courtyard looked like, what went on and who was present in these places. One of the most interesting aspects of this visit was how the visitor could not only imagine the place as it was in antiquity but also relate to the people frequenting these baths. One of the most interesting parts in the story telling on the activities within the baths included the reading of the petitions by visitors to the gods to punish others for any misfortunes they might have suffered at their hands. These intimate insights into the lives of ordinary people made the place feel even more real. Visually impaired visitors can make use of a fully descriptive audiotour and a British sign language tour.

The site is committed to increase wheelchair accessibility in all areas of the heritage building.

The Roman Bath’s website (<https://www.romanbaths.co.uk/accessibility>) gives clear instructions and information for a number of categories of visitors for special needs, these include; visitors with limited mobility, visitors with hearing impairments, visitors with visual impairments, visitors with autism, visitors suffering from potential claustrophobia as well as visitors with dementia. The website offers a number of downloadable resources to help visitors with

special needs plan their visit. These include an accessibility guide, maps for wheelchair users, a visit planner for visitors with autism and a detailed visual planner to help such visitors understand in advance challenges they might face when visiting the museum.



Photos showing large format projection is used to explain how the different areas within the complex were used. Some of the projections made use of semi-transparent canvases which used the foreground of the room as background of the projection, effectively creating a form of large-scale mix reality.

Source: Taken by myself.

A number of intelligently paced video projections in different parts of the museum allows the visitor to better understand the different settings within the baths. Through these projections rooms spring to life, projection on semi-transparent screens creates an effective hologram effect.

The museum also included a few hands-on experiments such as a demonstration on the effective use of pulleys to move water head stones. These together with the effective use of digital tools available in the museum and animators ensured that visitors to the site had an enjoyable and satisfying experience. This could be clearly seen by the fact that most users were listening to their audio guides at each and every point, families and visitors travelling in a group often stopped to point out interesting facts or discuss issues relating to what they were seeing. The interpretation tools available generated substantial interest amongst visitors.



Photo showing a large interactive touch table showing the whole Baths complex. This setup allowed multiple users to interact with the table simultaneously.

Source: Taken by myself.

The last exhibit in the visitor experience used a multitouch table connected with a large video wall display which allowed visitors to explore the different rooms in the baths and from a bird's eye view of the map one could look at the different people and their activities inside the different rooms being a multitouch table various users could use the same unit simultaneously.

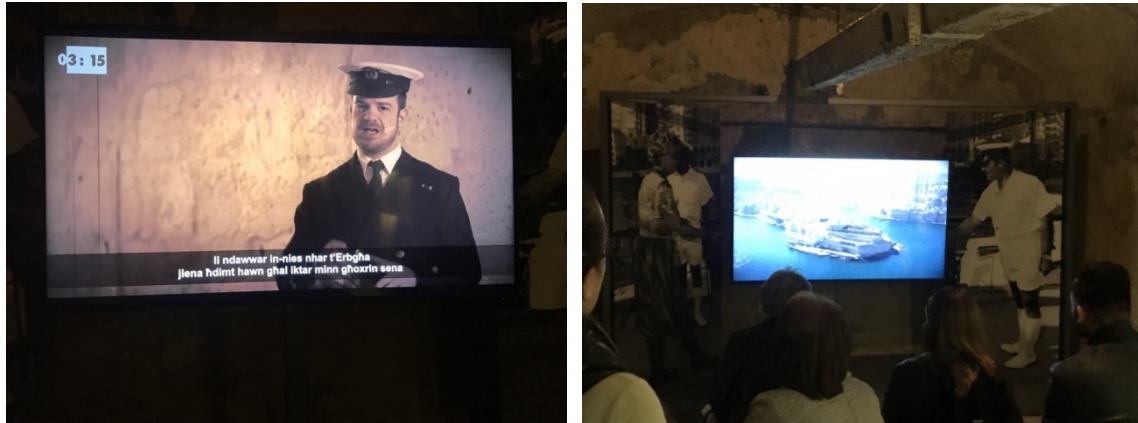
APP3.5.11 Behind Closed Doors Temporary Exhibition

Venue:	Fort St Angelo
Type:	Exhibition – “Behind Closed Doors”
Address	Birgu Waterfront
City	Birgu
Country	Malta
Admission	€ 10
Date Visited	April 2019
Website	https://www.musicinmalta.com/

“Behind Closed Doors” is a temporary exhibition by Heritage Malta setup in the once closed and very restrictive British Military base located at Fort St Angelo. The Royal Navy was stationed within the fort for more than 70 years (1906 – 1979). The iconic fort symbol of Malta’s resistance and victory over the invading Turks was out of bounds for the Maltese civilians, and accessible only to servicemen. On the 21st of March, the British military forces left Fort St. Angelo, the last military site on the island. The exhibition is meant to shed light into the activities and purpose of this fort, which was always administered by the foreign powers in Malta, during this specific part of its history, as well as focusing on the personal connection with Fort Saint Angelo.

I first visited the fort and exhibition during an extended hours event allowing visitors the possibility to experience the Malta fireworks festival being held in the grand harbor. The visitors

were a good mix of locals and tourists who took the opportunity to visit the fort, view the exhibition and enjoy a bird's eye view of the fireworks. Since I felt I had not had enough time to experience the exhibition and observe the visitors properly I decided to visit again in June.



Photos taken in the first room of the exhibition showing a short documentary aimed at putting the visit into historical context explaining what the whole “Behind Closed Doors” exhibition is all about. Whilst the concept was very good the actual execution and finish of the video was not professional enough.

Source: Taken by myself



Photo left: didactic boards are further enhanced by looping video screens.

Photo right: a large projection on to a sail of a reconstructed Phoenician boat which also serves as cinema seating. This is part of the permanent interpretation area of the fort.

One of the shortcomings of the signage and visitor route of the temporary exhibition was that it was at times difficult to know what was part of the temporary exhibition and what was part of the permanent exhibition.

Source: Taken by myself.

Whilst exploring the Fort, visitors can “enroll” with the Royal Navy in one of the 4 ranks available. The exhibition which is spread over five different areas in the fort allows visitors to explore the history and life within the fort, through recreated areas such as the dormitories and the bar.

APP3.5.12 MUZA

Venue:	MUZA - The Malta National Community Art Museum
Type:	Museum
Address	Auberge D'Italie, Merchants St, Valletta
City	Valletta
Country	Malta
Admission	€ 7 - Adults
Date Visited	March 2019
Website	https://muza.heritagemalta.org

The newly opened National Museum of Art in Malta (MUŻA) opened its doors to the public in 2019. The importance of this museum is not only because of the significant collection of art but because it marks an important development in the evolution of museums in Malta. Throughout the last 4 years I have had several interviews and meetings with MUŻA lead curator Dr. Sandro Debono and was able to follow with interest the development of this project. With an investment of more than 10 million Euros, MUŻA has been designed in line with the latest museology developments in Europe and beyond, making it an important milestone and watershed in the development of museums in Malta. MUŻA has been described as a “community-oriented project ... promoting art and museums as a tool for social transformation.”

The use of digital tools within MUŻA can be found in almost every hall. There are 3 types of digital tools used so far, sensor driven displays, touch screen interactive displays and

looping media. The use of these digital tools emphasis and reflects the main strategy of the Museum whereby visitors are no longer audiences but become participants.



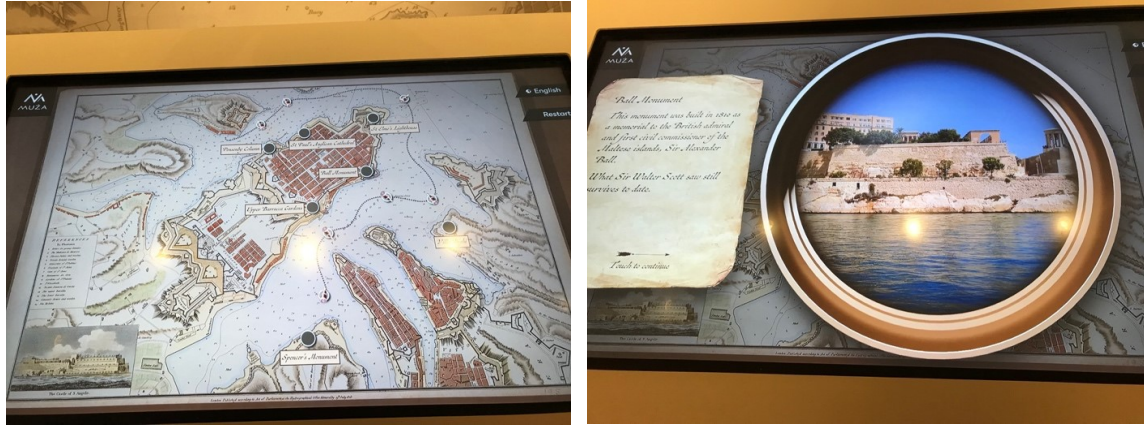
Photos showing examples of the digital signage tools used within MUZA.

Left Photo: shows the wheelchair friendly info kiosk.

Right Photo: the sensor driven info kiosks welcoming visitors to the museum.

Source: Taken by myself.

The reception area is not clearly visible from the entrance of the museum and a feeling of “coldness” greets the visitor. The first item one finds upon entering the museum is an info kiosk designed to be accessible by wheelchair users. When I visited MUZA this kiosk appeared to be switched-on but nothing was working on screen. On your way to the entrance turnstiles are a series of large portrait screen displays showing looping video clips of people from different walks of life. These screens are fitted with proximity sensors and are meant to address the visitor who will be passing in front of them. It appears that the proximity sensor on these screens was not working and nothing happened when the visitor walked in front of them. The whole point of these digital units is thus lost and visitors ignored them completely as they made little sense the way they were playing. The fact that the first two items to greet the visitor were digital tools which were not working properly gave a bit of bad first impression.



Photos showing screenshots of the viewpoints interactive display.

Source: Taken by myself.

Touch screens allow visitors to the museums to discover information by using the interactive touch screens. One such example is a 55" touchable placed in front of a large graphic of the coastline of Valletta. By clicking on a number of anchor points placed on a nautical chart on the touch screen, they would be able to see contemporary photographs or reconstructed views as they would be seen from these points at sea. Visitors using this touch screen were very interested to see how monuments which were removed or destroyed would actually look if they were still there.

Reconstructions of such monuments were made using 3D modeling or manipulation of sketches. I could observe visitors spending substantial time in front of this screen. Maltese visitors seemed to enjoy the experience more than foreign tourists. The graphics and navigation were very professionally done and content was interesting. This exhibit is meant to allow visitors to understand the various layers of history that make up Valletta, especially the influences brought about by the British period. It also helps visitors identify some of the early British monuments and architectural elements, and recognise their historic value as an integral part of the harbour's landscape. As can be seen from this display the specific learning outcomes are

wide and will probably be carried outside of the museum by the visitor, who will remember what he or she has seen on screen when visiting the grand harbour area. The only negative point about this unit was the placement of the lights overhead which reflected quite a lot on the touchscreen.

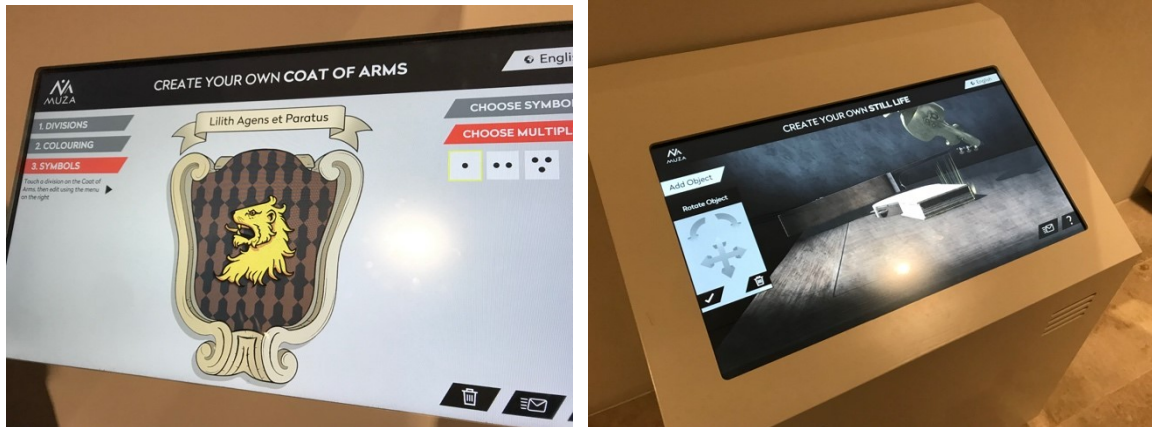


Photo left: Screenshot of coat of arms which my daughter created for our dog.

Photo right: screen shot of create a still life application.

Source: Taken by myself.

Another interactive display can be found in the area within the museum dedicated to allegory, heraldry and mythology and how these have influenced art in Malta. Visitors can use this display to build their own coat of arms. An intuitive interface allows the user to easily go through the process of creating a coat of arms, including bisecting or quartering the shield, selecting symbols and choosing background patterns and colours. An explanation of the symbols being used would have helped explain the use of symbols better. Once the coat of arms is created the visitor can email himself a copy of their creation, unfortunately this feature was not working. The Still Life interactive allows participants to create their own still life from a library of 3D items. Using the UI of the application to manipulate and drop items onto the still life canvas was not that smooth and I could notice a number of visitors easily giving up when using this display.



Photo left: showing the digital screen in front of the physical 3D of the monument.
Photo right: a screen grab from the 3D walkthrough.
Source: Taken by myself.

The hall displaying Antonio Scortino's works is probably one of the most impressive in the whole museum. The carefully displayed works by Scortino give a feeling of speed and forward movement which captures the attention and imagination of anyone entering this hall. Another excellent piece is a digital display showing a 3D walk through of Scortino's Monument to the unknown soldier which allows visitors to visually appreciate the scale and complexity of this monument. The 3D model and walk through allows visitors to better imagine this fantastic design which was never built. The impressive display uses various sketches and drawings by Scortino blended into the 3D walkthrough. Visitors can also appreciate the genius of Scortino as an architect, sculptor, curator and artist

APP3.5.13 Music in Malta from Prehistory to Vinyl Temporary Exhibition

Venue:	Mdina Cathedral Museum
Type:	Exhibition – “Music in Malta from Prehistory to Vinyl”
Address	Archbishop Square
City	Mdina
Country	Malta
Admission	€ 10 – Adults (part of the museum, cathedral entrance ticket)
Date Visited	April 2019
Website	https://www.musicinmalta.com/

“Fondazzjoni Patrimonju Malti” is a Maltese Heritage Foundation set up to promote and preserve the islands’ cultural heritage. Its principal aim is that of spreading awareness about the rich Maltese cultural heritage both locally and abroad, through exhibitions, publications and museums. Each year the foundation organises exhibitions relating to various topics connected to Malta's cultural heritage bringing together various artefacts from private collections and museums. Exhibitions organised by “Fondazzjoni Patrimonju Malti” have become very popular and sought after by the public due to the excellent quality related to the way the exhibitions are displayed as well as the information available to the visiting public.

For the first time ever, the foundation has this year teamed up with the Mdina Cathedral Museum to bring one of its biggest exhibitions so far. This year's exhibition is titled: “Music in Malta – From Prehistory to Vinyl”. And focuses on the history of music in Motown from prehistoric times all the way so the early 20th century.

For this exhibition to be held at the Mdina Cathedral Museum the art gallery halls within this museum had to be completely dismantled and put into storage for the duration of the exhibition. This was no small ask because it meant handling some very important, priceless and large paintings which were on display at the museum. The exhibition was open to the public from the 14th of April till the 16th Of June 2019.



Photo left – the Tonwelt audio guide was used as a wireless receiver and would play the stored audio file relative to the area that the visitor was in.

Photo right: the hands-free audio guide and the multi-screen projections created a feeling of immersion for the visitor who did not have to worry about pressing buttons relative to the area he was in.

Source: Taken by myself.

Before entering the exhibition area, visitors are given a hands-free audio guide with headphones, which they wear throughout their visit. Visitors do not have to interact with the audio guide at all whilst visiting the different sections of the exhibition. This hands-free approach meant that visitors could forget about the audio guides and focus their attention to the narrations being played automatically as they moved along the exhibition route. The audio guide did not explain every single artefact, and some visitors would simply move on as soon as

the narration for that area finished, not stopping to look at individual artefacts not specifically covered by the audio guide.

Triggers, strategically placed in the different sections of the exhibition area, automatically communicate with the audio guide and play the narration relative to that particular area. The content playback is very engaging and uses ambient sound, sounds related to the artefacts being described apart from the didactic narration. The audio guides were worn around the neck from a lanyard attached to it. This meant that the receiver sensor on the audio guide was facing the floor rather than the ceiling mounted transmission sensor. Unless the user kept the audio-guide facing upwards the connection between the transmitter and the audio guide would not be achieved and the user would not realise that there was a narration for that particular area. Having to hold the audio guide facing and pointing upwards was a bit counterproductive to the hands free experience desired by the exhibition curator. Even with the audio guide facing upwards there were a few black spots within the exhibition route where the communication between transmitter and receiver seemed to struggle more than in other places. I could see visitors communicating with each other asking if anything was being heard and if there was any playback in some areas of the exhibition.



Photos of Looping video projections placed next to a number of artefacts explained the subject in a more visual detail and easy to understand manner.

Source: Taken by myself.

The exhibition uses a number of multimedia digital tools to explain the evolution of music over the centuries. Apart from the audio guides, a number of large format projections create an immersive experience to the visitor. One of these projections animated a physical scroll which because of its length could not be completely displayed to the public behind a glass protective cover. In other sections of the exhibition a looping video on smaller LED screens was used to further explain how different musical instruments were produced or used. All this was meant to help visitors there understand better the subject material.

“Music in Malta – From Prehistory to Vinyl” Effectively used digital tools tool communicate and explain the subject content of the exhibition to the visitors. The exhibition audiences were split between local audiences who follow the yearly exhibition by the foundation as well as walk in tourists visiting the catty Cathedral and Mdina museum whilst visiting Mdina. The average length of their visit was dictated by the length of narration on the audio guide. Visitors would normally move to the next section once the particular narration was over. From my observations I could see that the level of interest shown by both types of audiences was practically identical.

APP3.5.14 The Money Gallery at the British Museum

Venue:	British Museum
Type:	Money Gallery
Address	Great Russell St, Bloomsbury
City	London
Country	UK
Admission	Free
Date Visited	February 2019
Website	https://www.britishmuseum.org

The British Museum Money Gallery

The development of the British Museum Money Gallery is significant not only for the sheer size of the numismatic collection itself but also because it was the British museum who led the change in alternative numismatic collection display and interpretation.

In 1985, the British museum organised a major exhibition entitled “Money: from Cowrie Shells to Credit Cards”. What was significant about this exhibition was that the Department of Coins and medals focused on money in general placing coins, banknotes and other forms of wealth storage into a much wider cultural and monetary perspective and context. The exhibition clearly demonstrated that the approach was not only appreciated by the numismatic community but also attracted huge public audiences. Since this first exhibition, museums and curators from around the world have been inspired and encouraged to present their coin collections in similar

fashion. Following the success of the exhibition, the museum decided to develop a permanent collection on the same guidelines of the exhibition (Orna-Ornstein, 2001) .

Gallery 68 on the museum's upper floor and along an important visitor route was identified for the display of the permanent collection. Its long rectangular shape makes it very similar to the hall at the Mdina Cathedral museum hosting the current coin collection. The gallery's twin entrances at each end of the hall meant that visitors could start experiencing the exhibits from any end. The displays followed a chronological timeline covering the development of money through the ages. As part of this framework, monetary history is represented through a series of thematic units.

The Money Gallery's aim was to present the money collection within an easily recognizable context which could be related to and understood by any visitor making them feel part of the continuing development of money.

Before actual work on the design of the Money Gallery itself started, a study by curators from the coins and medals department of other galleries within the British museum as well as other London national museums, looked at how existing displays, were being used to engage the public. Apart from this study, five external museum experts published a review of permanent galleries within The British Museum. This review, "Delight in Diversity: Display in the British Museum" (Cherry & Walker, 1996), was discussed with a large multidisciplinary team of British Museum curators, educators, designers and administrators.

In the first design of the money gallery in 1996, the use of digital tools, mainly video and computer based information, was discussed, but not included in the designs for 3 main reasons; firstly not to create bottlenecks caused by people standing in front of digital display or interactive units, secondly there was no budget allocation for digital tools and finally there was no time to

produce content for the digital units. This is very interesting to note, in that although the British museum acknowledged the impact digital tools could have on visitors, they were very reluctant to use them. The fact that no budget or resources was allocated to implement these digital tools shows clearly that the team did not really appreciate the added value that such tools could contribute to the overall visitor experience.

The design of the HSBC gallery had significant resources in terms of resources and expertise. The sheer number of curators and experts from different fields involved in the project is testament of this. The Mdina Cathedral museum would never have such resources available and this is why it is important to follow what was researched and implemented in big museums like the British museum and the Ashmolean and adapt the best practices and research to their needs.

The rectangular room allowed displays to be easily organised in a chronological manner. The main displays were set against the walls, with smaller one-off displays in the middle. Designers wanted to ensure that the overall presentation was easy to follow and whilst it was systematical to follow in a chronological order they also wanted visitors to be able to understand the displays if viewed randomly or if they paused their way along the exhibition route. Careful consideration was given to the fact that coins are very small in size. To be able to be viewed well, users would need to be as close as possible to them and with good lighting. The coins are thus placed as close as possible to the glass, with strong overhead lighting. The vertically mounted objects slope away slightly to allow as much light as possible to fall on the coins in order to maximize visibility. It was decided that in order to maximize viewing for the absolute majority of visitors the maximum display height would be limited to 1.6m from the ground, whereas the base of the displays would be 0.45m from the floor.

Since visitors looking at coins would be standing very close to the display case, it was decided that a top banner would be used to highlight the title, theme, date and a short description of not more than 20 words of the display case. These banner titles would have a bigger font size so that they could be read from a distance.

Colours for the panel fabrics was tested to ensure that the room remained as light as possible whilst ensuring the hall did not feel claustrophobic. Wherever possible, larger objects were mounted on light fabric, whereas very small items like coins were mounted on darker fabrics as this caused the visitor's pupils to contract making it easier to focus on the smaller objects like coins. The reason for the use of larger objects was twofold. Larger objects attracted casual visitors who would otherwise keep on walking without looking at the individual coins and they also provided insight and context for the themes on display.

To coincide with the launch of the HSBC Money Gallery, the British museum issued two publications meant to make the collection even more accessible. The first publication, *Money: a History* (Williams, Cribb, & Errington, 1997) was targeted at adults whilst the other publication, *The Story of Money* (Orna-Ornstein, 1997) was targeted at children. A teacher's pack was also devised aimed at helping teachers prepare themselves prior to getting their students to the museum by providing supporting teaching materials.

It was interesting to note that notwithstanding the significant human resources available for this project a number of revisions to correct spelling mistakes and minor curatorial inaccuracies was still needed, and a programme of continuous updating of the gallery was implemented. Following the initial launch of the HSBC Money Gallery the British museum conducted a number of studies to examine visitor experiences within the Hall in order to make the necessary adjustments in an effort for continuous development. One such report, *Evaluating*

the Galleries of The Department of Coins and Medals at the British Museum (Gaxho, Skene, Skorinko, & White, 2009), prepared under the guidance of Dr Katherine Eagleton, from the Department of Coins and Medals of the British Museum, evaluated the permanent Money Gallery exhibition in Gallery 68 and a temporary exhibition about Iranian coins in Gallery 69a to examine the impact that displays had on visitors. This study allowed the museum to identify the need that the content and displays of certain cabinets within the permanent gallery be updated and modified. It also allowed fine-tuning of the educational programme combined with the Money Gallery.



Photos showing our visit to the British Museum, left Dr. Edgar Vella – Curator Mdina Cathedral Museum, myself, Dr Barry Cooke – senior Curator Department of Coins and Medals, Dr. Gerald Montanaro Gauci – Project Manager Money Gallery.

Source: Take by myself.

The Mdina Cathedral Museum is currently undergoing a huge redevelopment progress of the Numismatic collection. I have convinced the project team to base the new design on new museology trends. In May 2019, I convinced the Mdina Museum Curator Dr Edgar Vella and project leader Dr. Gerald Montanaro Gauci to conduct a fact finding visit to the British Museum specifically within the Department of Coins and Medals (DCM). During our visit, hosted by DCM senior curator Dr. Barrie Cook, we had the opportunity to discuss a wide range of topics related to coin conservation, displays, interpretation methodology and concepts and challenges faced during the Money Gallery design and subsequent redesigns. This visit was very useful in that we could get a first-hand account of a curator who was on the project team of the British museum project. Dr Cook showed us around the money gallery himself and explained the different approaches taken with the choice of displays, showcases, interpretation colour schemes etc.



Photo showing a Money Gallery Volunteer manning the hands-on station allowing visitors to touch ancient coins.

Source: Taken by myself.

The above photo shows a museum volunteer manning a portable display unit which allows visitors to touch and hold actual coins from the collection. This was one of the most interesting exhibits to catch visitors' attention. From my observation point I could see many visitors, especially families and younger visitors, approach the volunteer, ask questions and get to handle the different coins on display. The role of the volunteer was to ensure that only one visitor at a time was handling coins, so no coins would go missing and answer any questions that visitors might have. The volunteer explained that in a typical morning she would have anything between 300 to 500 visitors approaching her station to ask questions and hold the different artefacts on display. She said the most common question was related to the value of the coins and what could be purchased with them.



Photo showing display units with embedded digital signage.

Source: Taken by myself.

Some of the display cases incorporated small 10” digital screens which showed a looping video clip explaining or related to the artefact. All the screens in the gallery were not interactive which meant users could not really explore anything on them except what was being presented. I did notice a few random visitors try to tap the screen to see if it was a touch screen. Curator Barry Cook explained that the museum was a bit reluctant to use digital tools as these tend to break down with usage meaning they need continuous maintenance.



Photo showing a typical display unit, the use of artefacts such as jewelry or pottery linked to the topic being discussed breaks the display monotony of coins.

Source: Taken by myself.

Display cases in the Money gallery used a 4 colour scheme to highlight the different bits and pieces of information. Red is used in the main title at the top of the display giving an overall heading / summary of what that display case was about. Red is also used as a background behind specific artefact displays which need to stand out and given that extra bit of importance.

Artefacts were mounted on a light or dark grey background, helping to effectively breakdown the display into boxes very similar to what you would find in story boxes in comics. The lower part of the display case gave detailed contextual information related to regions or additional details on some of the artefacts.

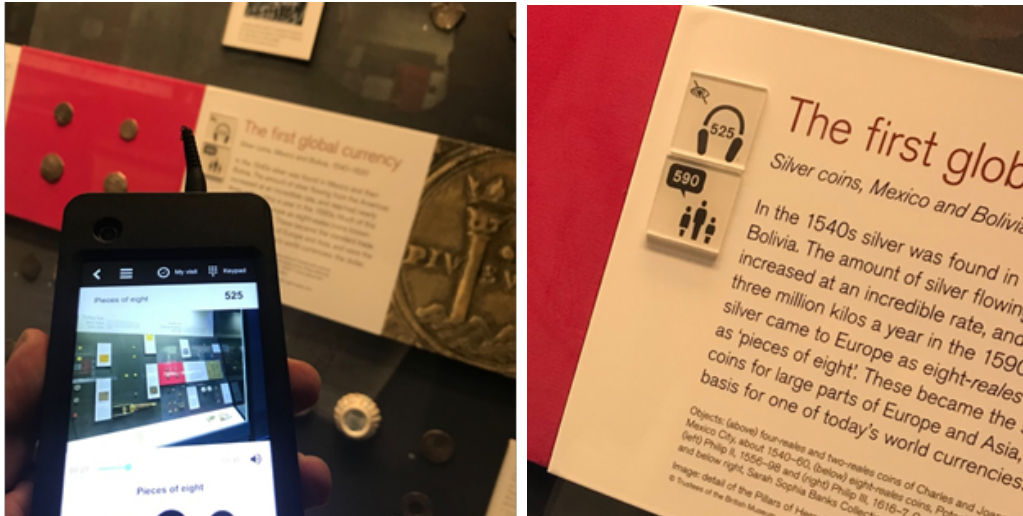


Photo Left; Video/audio guide Photo Right: Signage with Audioguide reference Number.
Source: Taken by myself.

A multilingual audio guide for the museum could be purchased separately from the main reception. A number of exhibits in the Money Gallery had numbers next to them which corresponded to narrations on the audio guide. An image on the audio guide relative to the display being seen helps the user ensure he is hearing the right audio file.

APP3.5.15 The Ashmolean Museum

Venue:	Ashmolean Museum
Type:	Money Gallery
Address	Beaumont Str
City	Oxford
Country	UK
Admission	Free
Date Visited	February 2019
Website	https://www.britishmuseum.org

The Ashmolean Money Gallery

The Ashmolean Museum of Art and Archelogy is Britain’s oldest public museum (MacGregor, 2001). Ten years ago, the museum underwent a major transformation, 39 new galleries were built and a doubling of the overall exhibition space. The museum’s Coins and Medals department has more than 300,000 items in its collections making it one of the most important coin collections and a centre for research and teaching of numismatics. The project saw the setting up of a new Coin Study room, Coin Store and a flagship Money Gallery. The Ashmolean Money Gallery brief explained that the new gallery aims to explore the importance of money as a universal feature of human life, and the light coinage throws on history. This aim is clearly much wider than simply representing the development of money over a historical timeline. The final deliverables of the Money Gallery included seven thematic displays focusing on the use of money in different societies, historical displays of coinage by civilization, display of “star”

objects, local numismatic finds and displays targeting specifically families and children. The design of the Money Gallery was a multidisciplinary team effort. Curators, museum educators, designers and consultants worked together to design the visitor experience.

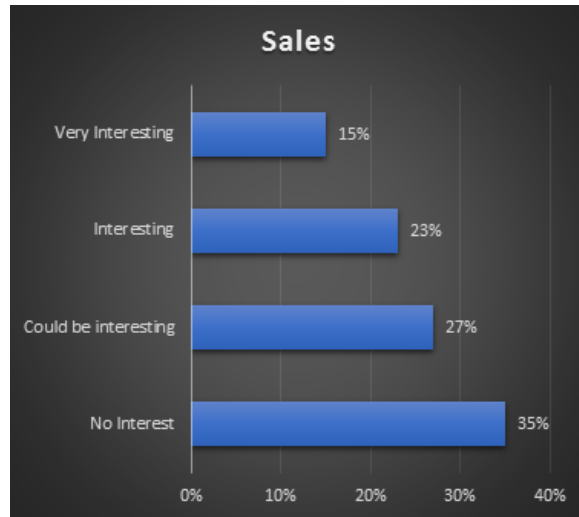
A case study about the Ashmolean Money Gallery was presented by Dr. Effrosyni Nomikou entitled *The Other Side of the Coin - Audience Consultation and the Interpretation of Numismatic Collections*. This paper, together with various others dealing with the subject of museum interpretation, was published in the book *Museum Gallery Interpretation and Material Culture* (Fritsch, 2011). This collection of papers follows the first international conference on the role of museum interpretation held at the Victoria and Albert Museum in London.

Once the initial gallery design brief was completed, front-end evaluation was carried out to investigate visitors' familiarity, preconceptions and attitudes on the subject of Money and to try to find out visitors' needs and expectations when visiting the gallery. Museum visitors were approached and asked to respond to a short interview. Open ended questions intended to allow answers in the visitor's own words were used. In all, 52 respondents were interviewed and their answers categorized according to the research areas highlighted earlier. Responses allowed researchers to find out what influenced the visitor's plans for visiting galleries.

The following are the main findings from the interviews:

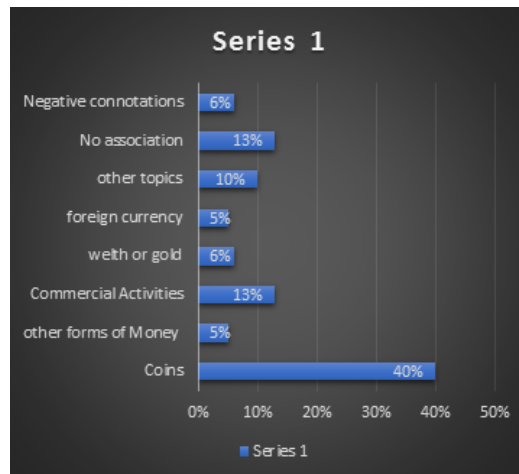
Is the Subject of Money Interesting?

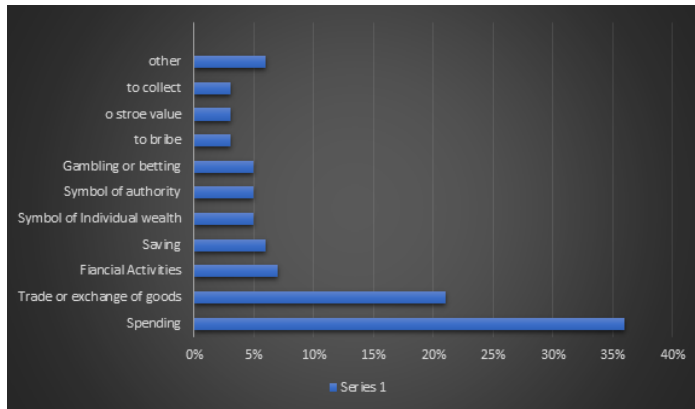
The biggest group of visitors (35%) did not find the subject interesting compared to only 15% who found it very interesting. By looking at the comments given by the visitor on could gain a lot of insight of what they meant by “interesting”.



What do you Associate Money with?

Most visitors associate money with coins (40%). 6% of visitors have negative feelings about money. A good 15% associate money with commercial activities such as banking, or markets. Only 5% mentioned money in other forms other than coins. Whilst 10% of respondents found no association whatsoever with money





What is Money used for?

36% of all visitors think that money is used primarily for spending or for trading and exchange goods. 21.7% - Financial activities such as banks and stock exchange are the next biggest category, but there were also many different answers which goes to show that many people think that money can be used for a wide variety of purposes.

Visitor suggestions

Finally, visitors were asked to propose their own suggestions and ideas for the redesign of the new gallery. 72% of all visitors had some suggestion to offer, but since the suggestions were quite varied these were split into two main categories; 60% content and 40% presentation:

Content Topics	Display Topics
<ul style="list-style-type: none"> History of coins and linked historical events 	<ul style="list-style-type: none"> Avoid flat display cases Less crowded displays

<ul style="list-style-type: none"> • The value of money – what can be purchased with it • Interesting stories connected with the coins • Other types of Money • The production of Money • Banking • British Money 	<ul style="list-style-type: none"> • Since object are very small to see they should be supplemented with larger images • Family friendly • Provide maps and Geographical links • Have seating facilities • Have handling activities
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One of the most interesting outcomes of this research was the way that some visitors looked at money as a contested subject often linked with evil, linking it with negative connotations such as bribery, avarice and greed, corruption and fraud. This made the designers realize that money had wider connotations than was originally thought and this had to be somehow reflected in the gallery presentation. The human element of money was another important feature. Visitors were looking for human centred connections with the exhibits, wanting to hear stories connected with the displays. The majority of the visitors also wanted the narrative to be related to the use of their own money. All these findings helped the curators realize that the display of the money gallery had to be wider in scope than originally envisaged.

By using prototype testing the museum could test how users would react to the display designs being planned. Valuable feedback was carefully documented to be used to make the necessary changes. Since one of the specific target audiences decided by the museum included families and children, these audiences were consulted and involved at the prototyping phase. The evaluation showed that even collections which have limited appeal to general

audiences can be turned into attractive exhibits once the visitor needs and expectations are understood and catered for.

During my visit to the Ashmolean museum I met with Steve Pearse, the project manager responsible for the complete setup of the display cabinets in all the galleries at the Ashmolean. Mr. Pearse, who is the UK business manager for Mayvaert, an international leader in Museum display cabinet design and production, spent the day taking me around the Ashmolean explaining the different challenges encountered with setting up the displays in the different halls.

The longest time spent within the Ashmolean was within the Money gallery where I could see first-hand the different display cabinets used. Mr. Pearse explained in detail how the designed cabinets used to display the coins reflected the research carried out with visitors. The coin displays were all vertically facing the user. Rather than individual standalone cabinets, a flowing seamless display of connected display cases was used. The custom designed display show cases were very securely fitted given the precious contents within. The huge glass fronts of the cabinets sometimes proved quite challenging to open, so special hydraulic systems were used to make opening and closing such displays easily.

I found the meeting with Mr. Pearse especially interesting because I could discuss practical issues about exhibition design, especially planning and preparation, logistics and unplanned difficulties which arose during the installation. I could appreciate that only a team effort and close collaboration between all involved, including external suppliers could guarantee the execution of a well-designed exhibition. Although digital tools were integrated into displays and used in other halls within the museum, none were used in the Money Gallery. The following photos taken during the visit help illustrate how the designers implemented the research findings into the actual final display.



Photo showing the unobtrusive, recessed display units built into the wall of the money gallery.
Source: Taken by myself.

Recessed display cabinets, with a front flush finish, eliminated the feeling of coin cabinets or individual show cases. This gave a feeling of continuity and a balanced display. This particular section of the money gallery shows coins by region. Next to each display an enlarged photo of one of the main coins on exhibit is shown, allowing visitors to examine the coin's detail, something which would have been quite difficult to see on the actual coin due to size. The amount of coins on display in each section was kept to an absolute minimum thus avoiding confusion and over cluttering.



Photo showing a wall mounted display.
Source: Taken by myself.

Coins were organised into various thematic displays. The one above showing the relation between Money and power. These themes were all identified as part of the visitor research carried out in the beginning of the project. Display information was on 3 visual levels. The title at the top “Power and Money” immediately informs the visitor what that particular display is about. In the middle sections are the coins which are displayed at eye level directly in front of the visitor. On the left-hand side one can also see the inclusion of maps to explain the coins on display, this too was another suggestion by the researched visitors. The middle section

also has a short summary display about the main theme on display in this section. The lower part shows detailed information on the individual coins. This information appeals mostly to subject specialists or dedicated hobbyists showing additional interest in the topic.



Photo showing a hoard of coins.

Source: Taken by myself.

This is one very interesting display which is accessible from 3 different sides. The exhibit shows the discovery of a hoard of coins. This is the only display which shows so many coins in one cabinet. In the front left-hand corner of the photo one can see one coin on display with a focused light on it making it easier to look at. In the lower part just under the coin one can see a print of the enlarged back and front of one of the coins in the hoard and a small description next to it.



Left photo: This cabinet which deals with various metals (out of which coins are made) exhibits only 6 different coins. The focus is on the supporting objects which are much easier to explain the different metals used by linking them to easier understood objects such as weapons, jewelry and household items.

Right Photo: Although all the displays were designed vertical and coins were mostly available at eye level, some of the cabinets had drawers which could be pulled out to offer interested visitors additional information, without cluttering the main display with too many coins and information.

Source: Taken by myself.

APP 4.1 Background to the Mdina Cathedral Museum and the Albrech Dürer

APP 4.11 The Mdina Cathedral Museum

The Mdina Cathedral Museum is located in the very centre of the medieval town of Mdina. Located on the right-hand side of the Mdina Metropolitan cathedral and next door to the archbishop's residence, it forms part of a planned trio of ecclesiastical buildings and the seat of the archbishop in Malta. The museum building was originally built and used as a seminary.

In a recent publication, entitled "The Cathedral Museum of Mdina – A Monumental Baroque Complex of Maltese Splendour", Mario Gauci, assistant archivist of the Mdina Cathedral Archives, gives a detailed research into the history and architecture of this 18th century baroque gem, which today houses the Cathedral museum collection (Gauci, 2018).

In 1733 Bishop Fra Paolo Alpheran de Bussan laid the first stone of this magnificent baroque building meant to serve as the first purpose-built seminary in Malta (Stenson, 2018). The building was funded by De Bussan himself with the help of Grandmaster Manoel De Vilhena. Giovanni Barbara or Andrea Belli are most probably the architects of this magnificent building, which was inaugurated on the 20th May 1742. Styled like most of the baroque palaces in the area, the seminary is built around a large central courtyard which served to let in light and fresh air into the rooms all year round. The seminary's classrooms, dormitories, refectory, kitchen and stores are now the museum's halls. The Mdina seminary closed its doors in 1858, when it moved to Palazzo Manresa in Floriana. During the Crimean war, the building was used as the British Military headquarters. Due to heavy bombing in World War II, St. Edward's College was temporarily moved from Cottonera to the relative safety of Mdina.

Following a successful Marian exhibition in 1949, plans were initiated to convert the old seminary building into a museum. Archbishop Michael Gonzi and Governor General Sir Maurice Dorman officially inaugurated the museum on the 4th January 1969. The building itself, its character, original purpose, architecture and style form part of the museum's story and should always be taken into account when planning the visitor experience.

The core collection donated by Count Saverio Marchese, including rare prints, paintings, vestments and coins, was previously crammed into the Aula Capitularis and the sacristies of the Mdina Cathedral hence the name Cathedral Museum. These priceless artefacts were transferred to the new Cathedral Museum building once it was opened fifty years ago. The newly set up institution also included the priceless Cathedral archives which were opened to academics and researchers allowing them to study Maltese heritage. Mgr John Azzopardi was appointed the museum's first curator 1967–2002. Over the years the museum was very active in the cultural field, organizing conferences and exhibitions, foremost amongst these was the International Symposium "*Ecclesiastic Museums as Cross-roads of Faith and Culture*" organised in 1994.

Another important milestone for the cathedral museum was when the first biennale Art Exhibition was launched on the 14th January 1994. The original purpose of this Biennale was to re-analyse the state of sacred art at a time when other styles and artistic concerns reigned supreme, although the sacred element in local art has never really totally died. Since then the museum has taken a much more open approach towards modern and contemporary art. Over the years the museum published a number of high-quality academic publications and books.

When in 2004 the archives were moved out of the museum building to another building within Mdina, a major renovation project was undertaken. Over the last two decades most of the

halls within the museum were renovated. The areas previously occupied by the archives as well as other newly organised halls could accept new collections and museum acquisitions. The basement of the building was also completely refurbished and started to be used to house the Mdina Biennale. As part of the huge refurbishment and restoration project, collections were better displayed by being thematically and chronologically organised. As part of this refurbishment programme, the Albrecht Dürer collection was recently reframed and refurbished in May 2018.

APP 4.12 The Albrecht Dürer Collection

During the period of the Knights of St. John (1530 to 1798), art in Malta received a significant boost. Local and foreign artists were commissioned to paint not only in churches and palaces but also in many rich households. Count Saverio Marchese was one of the most important art collectors in Malta in the early 19th century. He was the first to bequeath his large collection of paintings, prints, art books and drawings to a public institution, being the Metropolitan Cathedral of Mdina (Gauci, 2018). The important collection of Albrecht Dürer prints found at the Cathedral museum was part of the Count's bequests to the Cathedral. The collection passed on to the cathedral chapter in May 1896 and included some 4000 prints, 75 paintings and 400 master drawings.



Photo Primo Costo - Registro di compere - Manuscript
on the art collection purchased in Malta by Count Saverio Marchese.
Source: Mdina Cathedral Archives.

The count acquired the Albrecht Dürer prints from two different sources. His manuscript 'Primo Costo' conserved today at the Mdina Cathedral Archives, detailed more than 400 purchases of works of art which he bought from artists and art dealers from Malta, England, Italy and Germany, more precisely Munich.

The manuscript shows that the 157 Albrecht Dürer and Old German Prints currently part of the museum's collection were purchased either from Count Francesco Serrati or from the Italian art dealer Filippo Benucci (1779 – 1848), a landscape and marine painter and lithographer. Apart from the 17 Dürer prints purchased from Benucci and brought over to Malta from Rome, between 1815 and 1830, the count bought the remaining 140 Dürer prints from an auction. This rich collection had been acquired by a certain Mr. John Robert Stewart from Count Francesco Serrati of Florence (Azzopardi, Malta, Buhagiar, & Week, 1982).

Count Francesco Serrati was born in Siena and, after studying at the University of Pisa, was employed in 1760 as a secretary in the Department of Foreign Affairs in Florence. By April 1784 he had risen to become Consigliere and second director of the Segreteria di Stato whilst on the 6th April 1789 he became governor of Leghorn. Later the same year he became Grand Prior of the Order of St Stephen. Count Serrati was nominated Florence's Secretary of State on the 9th of March 1796 but when Tuscany was overrun by the French he sought refuge in Palermo in the service of King Ferdinand. When in 1813 Serrati was on his way back to Tuscany, his ship was captured by corsairs and, together with his collection of prints, he was taken prisoner of the Bey of Tunesi. He died in Tunisia on the 1st of February 1814.

Count Saverio Marchesi's manuscript 'Primo Costo' is a unique and valuable source of information about the movement of the Serratti Art Collection. The collection was acquired by a Turk who in turn sold it to two Jews living in Malta – Cesana and Fano. These two sold the collection to a certain Canon Giuseppe Giovanni Bellanti (1787 – 1861) who in turn sold most of the collection to John Robert Stewart of the commercial firm Struthers Stewart & Co. Count Saverio, who happened to be a friend of Stewart, bought from him part of the collection at moderate prices. The rest Stewart auctioned, and from the auction the count bought the prized Libro Dürer (Azzopardi, 2018).

APP 4.13 Understanding the museum's audiences

Entrance to the Mdina Cathedral Museum is via a combo ticket which incorporates the Cathedral and the Museum as one joint ticket for all ticket categories. The Mdina Cathedral's imposing building and its strategic location cannot be missed by any visitor to Mdina. Comments left on social media, primarily the Google Business and Trip Advisor, show that many visitors to the Museum visit it because of the cathedral. Indeed, many of them only become aware of the museum when purchasing the combined ticket. Comments also show that visitors to the museum are very pleasantly surprised with the exhibits and layout of the museum and recommendation ratings are actually very high (refer to Appendix – Visitor Rating section). These very high ratings have earned the museum the Trip Advisor's "Yearly destination of Excellence" for the last 5 years and in 2018 won the "Customer's choice award" also by Trip Advisor which places the museum in the top 10% of destinations worldwide.

The Mdina Cathedral museum has 3 main audience groupings:

Group Tourists - Most group tourists are brought to Mdina in organised half day tours by a number of local tour operators. The visit to Mdina normally includes transport to the gates of Mdina by coach, a walking tour of Mdina, some souvenir shopping and a visit to the Cathedral. On Monday, Wednesday and Friday the amount of group tourists is significantly augmented since there would be cruise liners in the Grand Harbour on these 3 particular days. Group tourists normally have a very limited time in Mdina, very often not more than a couple of hours during which they try to cram as many things to see as possible. What the tourists in these groups see during their visit to Mdina is mostly decided by the tourist guide, who not only determines what they see but also how long they spend in each place.

When speaking to tour guides visiting the museum, I was told that groups normally have 3 stops in Mdina. The first stop is the Metropolitan Cathedral, the second stop is by the bastions to allow the visitors to enjoy the view and finally a third stop to purchase some souvenirs. Although an average of 53,000 group visitors a year visit the cathedral, the majority of these do not visit the museum itself due to time restrictions. These types of tourists do not have time to visit the museum let alone appreciate the redesigned hall.

Foreign Independent Tourists - Individual tourists are those who visit Mdina on their own, often armed with a guidebook or smartphone and they spend more time wandering about. These tourists would normally enter both the cathedral and museum. They are much less pressed for time than the groups and decide themselves how long they want to spend in the museum. German tourists within this category are the biggest fans of the Albrecht Dürer hall. Individual tourists account for

the biggest percentage of visitors to the museum. The museum does not have an accurate system of recording as to the nationalities of these individual visitors, with feedback from the ticketing officers being the only way of getting some form of indication.

Maltese Independent visitors - Maltese Visitors are the smallest visitor category. The few Maltese that do visit the museum are normally very interested in the subject matter. Maltese visitors tend to visit more than once, unlike tourists who are limited by their visit to Malta (unless they visit Malta again, they cannot visit the museum).

The museum has a very interesting learning programme for school children and every year thousands of school children from all over Malta visit the museum. On the other end, there is a small group of older Maltese visitors (60+) who not only visit the museum but also attend most of the events outside normal visiting hours that are organised by the museum.

The museum is currently working on an audience development programme to expand the existing categories of visitors as well as to establish new audiences. These audience categories have potential for growth. The Maltese visitors' category is probably the least developed category and has huge growth potential. Several EU funded projects are currently being implemented at the museum to develop existing, as well as create new, audiences. The museum aims at increasing accessibility to everyone, and one of the first projects being implemented to reach this goal is the target to make the museum the first autistic friendly museum in Malta by the end of 2019. The museum is also opening a learning centre in the basement to develop further the school children's visits to the museum. An area for temporary exhibitions for young Maltese artists is being set up

to encourage emerging artists to exhibit their works, thus raising the museum's profile within the local art community.

As explained in the literature review, Section 2.2 understanding museum audiences is much more than simply understanding demographics. To fully understand audiences the museum needs to understand the reasons why these visitors choose to come to the museum. Identifying what motivates visitors to spend some of their time at the museum is no easy task, but the new museum curator and management are open to the concept of understanding audiences more, and it is believed that, the better the museum understands its visitors, the more meaningful and engaging experiences it would be able to create. It would also be able to offer unique opportunities for attracting new audiences as well as developing further existing ones.