Immersive Media in Museums and Museum Education

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DEDICATION

Dedicated to my Mom and Dad for always supporting my dreams and standing by my side through thick and thin. To William, for always reminding me that I can do anything I put my mind to. Finally, to my Grandmother for always being my biggest advocate. This is for you.
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ABSTRACT

This thesis explores the use of immersive media, specifically augmented and virtual reality (AR and VR), as an educational tool in the museum space. My findings show that there are great limitations and benefits to implementing immersive media into a museum exhibit, but if done properly can be very rewarding for visitors. AR and VR can create memorable experiences for visitors in a time where attendance is declining in the arts. Technology can also increase time on task and enhance learning for visitors. These types of technologies have developed extensively in the past few years, to the extent that it is now time for museums to start using the technologies to enhance learning in their exhibits.
Imagine standing in the Sistine Chapel, looking up to the ceiling and seeing paintings by Michelangelo. There are shapes, colors, and people that cover the ceiling in this amazing historical landmark. Then imagine holding up an iPad and having the people, objects, and animals come to life in the painting and letting these figures educate visitors rather than having to guess who the people are or why they are important. An augmented reality app, like this one, could tell visitors why Adam’s hand is limp and who he is reaching out to. The characters inside the triangle arches could describe why they are there and their importance to religion. This could be something people can get excited about. This new augmented reality app could help educate viewers about all types of art without having to read a plaque, listen to a docent, or have an art history degree. Technology can allow visitors to become more engaged in learning.

This paper reports on research conducted to find out how immersive media can be used in museum programming to educate visitors. Museums can use immersive media like augmented reality (AR) and virtual reality (VR) to help engage the visitor in the experience. Immersive media are digital media tools which allow the users to be surrounded by 3D imagery and other virtual elements while also engaging the senses. Virtual reality (VR) refers to computer-generated environments that simulate the physical presence of people and objects to create a realistic sensory experience. VR allows the viewer to be completely immersed in a digital world. Augmented reality (AR) is when digital information is layered over a real space to produce a new and enhanced experience of the actual world. The layer is created by using a smartphone or tablet.
As technology continues to develop, museums should keep up with these technological changes to improve learning, engagement, and conservation. Technology is used constantly in the for-profit sectors like sports, medicine, and many others. This thesis aims to discover how technology can be used to enhance educational outcomes for museum exhibitions. Technology can be used for many different purposes such as audience development, marketing, and aspects of museum management. Museums can use immersive media like augmented reality (AR) and virtual reality (VR) so that their audience sees that they are up-to-date with current technology trends.

Museums are using these specific technologies in educational departments and visitor experience departments to help engage and educate visitors of all ages. There are various museums all around the globe that are already beginning to use AR and VR as part of their experience. For example, the Foundation of the Hellenic World (FHW) located in Athens, Greece uses VR to enhance its mission. The mission strives to make people conscious of the Greek culture and heritage. FHW strives to do this by being a reference to the past while also helping to shape the future. FHW uses VR to educate people about historic sites and landmarks in Greece. They do this by recreating ruins in Athens to show what they would have looked like thousands of years ago. The overall purpose of this tool for the FWH is to be used "as an educational/entertainment tool and as an instrument of historic research, simulation, and reconstruction" (Roussou n.d.). When visitors put on the VR headset they can be transported back into time to see the great cultural heritage sites of Athens, Greece.

In addition, the British Museum developed a “Virtual Reality Weekend.” Participants of the “VR Weekend” could experience objects from the Bronze Age that are part of the British Museum’s collection. The museum used the technology to enhance the objects on display. The
objects are projected into an immersive VR dome in the Bronze Age section of the museum where people can examine the different objects without them being behind a glass case. The museum wanted to prove that, “…the virtual presentation of objects does not detract from or replace real life experiences of them. Rather, our virtual reality environment enhanced our audiences’ interest and excitement about Bronze Age objects” (Center for the Future of Museums 2016). Feedback from users was very positive with people saying “Fantastic, interactive way to learn…it really helps visualize the height, and depth of a Bronze Age village” (Center for the Future of Museums 2016). This immersive technology allows visitors to interact with history which helps them learn more about that time.

In the U.S., the Cleveland Museum of Art created an AR app in which users can scan artworks with a mobile device, and learn more about the paintings. When the museum guest scans the artwork, there is extra text that describes what is in the painting and allows the viewers to get a deeper understanding of the artwork and artist (Alexander 2014). This organization and the others above are just a few examples of arts and culture organizations using immersive media to assist with the interpretation of their collections.

Immersive media should be on the minds of museum staff because the technology is growing fast and people are beginning to realize how fun and useful the technology is. The price is dropping for VR headsets like the Oculus Rift, and AR can be created for smartphones or handheld tablets at a small cost (Mitchell 2017). Many times, visitors bring their phones into museums, and all they would need to do is download an app that is created by the organization. The rising importance of these technologies can be seen in TrendsWatch 2016, published by the Center for the Future of Museums, which dedicated a section to virtual and augmented reality. The Center for the Future of Museums published a continuation of this discussion called “The
Connected Museum: Museums and the Matrix of Place-Based Augmented Devices” (American Alliance of Museums 2017). The article discusses different uses of AR and VR applications in museums, along with the benefits and limitations of these technologies. Technology is on the minds of museum staff and executives; I believe, museums should be looking to create apps or develop programs that involve immersive media to help solve problems that may occur.

I am interested in how AR and VR can be used in a museum setting because immersive media has developed far enough where I think the technology has great potential for museums. My recent employment with Cortina Productions has also piqued my interested in augmented and virtual reality. VR grabs my attention for the incredible features it can offer as an immersive learning tool. AR, on the other hand, enhances the real world to add a layer of dimension and learning which can be easily accessible to museum visitors. The commercial world has been using technology like this and now it is time for museums to take advantage of all the incredible features immersive media can offer.

**Literature Review**

There are several themes that will be covered in this literature review. The first is the history of immersive media. The history of immersive media will define many terms that will be used in this research paper and highlight the changes VR and AR have been through in the past 30 years. There are four benefits of AR and VR that are discussed including educational purposes, ideas for preservation of objects, and the effect it has to “educate, entertain, and dazzle” (Roussou n.d.). Then the limitations of those technologies will be reviewed such as how VR causes motion sickness and that overall the technology is costly. Next, this paper will examine ways some museums are already using immersive media. There are many museums around the globe already using VR and AR such as the Cleveland Museum of Art, the British
Museum, and the Powerhouse Museum in Sydney, Australia. These organizations use AR apps to enhance artwork and VR experiences to improve learning. The final topic in this review will be about how immersive media is being applied in an educational setting. Many universities in America are completing studies on how AR and VR can be used to enhance learning for students.

**History of Immersive Media**

Virtual reality (VR) refers to computer generated environments that simulate the physical presence of people and objects to create a realistic sensory experience. Augmented reality (AR), on the other hand, is when data is layered over a 3D space to produce a new experience of the real world. These are both considered immersive, because immersion occurs when someone is participating in a comprehensive, realistic experience that interacts with the senses (Dede 2009).

The term virtual reality was first used in the mid-1980’s when Jaron Lanier began to develop goggles and gloves needed to experience what he called virtual reality (History of Virtual Reality 2016). Before the term was coined, other inventors like Morton Heilig began to develop VR headsets in the 1960’s specifically for cinema that allowed viewers to be “in” the movie. After the term had been formed in the mid-1980’s, VR picked up speed in the science industry especially in National Aeronautics and Space Administration (NASA). NASA created the Virtual Interface Environment Workstation (VIEW) which required a head mount with gloves to allow for touch with computer applications, also known as haptic interaction (History of Virtual Reality 2016). Today, there are many different types of VR hardware that can be purchased for various ranges of pricing. One of the most well-known of these is the Oculus Rift headset created by Oculus and later bought by Facebook. These headsets can cost upward of
$600 depending on other accessories needed. The Rift, like many headsets, requires users to have a high-end PC to connect to the headset, or some headsets can connect to an Xbox game console (Oculus Rift | Oculus 2017). The HTC Vive is another VR headset that runs for upward of $800 depending on accessories needed (VIVE™ | Buy Vive Hardware 2017). Both the HTC Vive and the Rift require high-end PC computers to run the games and other programs that the VR headsets allow for. If you do not have the computer or Xbox to run the programs, then you will not be able to use either type of headsets. The cheapest VR on the market currently is the Google Cardboard. The Google Cardboard is a piece of cut out cardboard that users can easily assemble, then insert their phone into a slot built in the back of the Cardboard. This is the cheapest because the software is designed as apps that can be downloaded onto a smartphone and the hardware is a simple piece of cardboard. The Google Cardboard was given to New York Times subscribers for free in fall of 2015. People can also purchase a Google Cardboard for only $15. It does require a smartphone, because the VR apps need to be downloaded to a phone (Wohlsen 2017). VR is the more expensive immersive media hardware compared to augmented reality.

AR follows a history timeline similar to VR. The first type of AR was recorded back in the 1960’s with an optical see-through head-mounted display created by Ivan Sutherland. In the early 1980’s the term augmented reality was coined by Tom Caudell and David Mizell while helping workers assemble wires on an aircraft. AR was officially defined by Ronald Azuma in 1997 as the combination of the digital and real world (Carmignani 2011). Today, AR is used mostly on TVs, smartphones, and tablets. Two well-known AR applications that many people see on a regular basis are utilized by the National Football League (NFL) and the app Snapchat. The yellow first down line in NFL football games can only be seen to people viewing the game on a screen. The line cannot be seen in real life by the NFL players. The other AR app that is
used on mobile devices and tablets is Snapchat. Snapchat is an app that is used to send pictures to friends and family that can only be seen for up to 10 seconds. In this app, users can add filters to their faces like dog ears with movable tongue with an additional barking noise, or wearing beautiful butterfly crowns and headbands, and other vast numbers of augmented filters for people to choose from. These filters can only be seen on the device using Snapchat. The app does this by using face recognition software and augmenting your reality so that you have dog ears or scales like a snake. Once the video or picture is taken with the AR feature you can send it to your friends that are on the app. Snapchat has recently launched a new addition to the app called New World Lenses. This feature allows viewers to add stickers and pictures onto their Snapchat images and videos. For example, a person can augment their reality by adding a rainbow above a loved one’s head. This new addition no longer restricts augmentation to face recognition software (Snider 2017). The hardware for AR is very limited, but recently Microsoft developed the HoloLens. This is a wireless headset that augments people’s realities. It is still in the preliminary stages and is mainly used for gaming. The headset costs $3,000 or more and is quite heavy to wear for an extended period of time (Microsoft 2017).

For both immersive devices, programmers can create apps, games, and interactive learning tools on an application called Unity. Unity allows designers, programmers, animators and even newbies to design games and other tools for 3D spaces like AR and VR. Unity was initially developed for VR and was meant to allow development in a 3D space rather than 2D. Unity can create games for mobile, desktop, the web, and consoles. Initially, Unity is free, but you can upgrade for high-quality control and other advanced features (Zamojc 2012). AR and VR are two different types of immersive media that that each has strengths and weaknesses.
**Benefits of AR and VR**

AR and VR each has benefits and limitations when using these types of technologies in the museum. One of the main advantages is the overall experience that these technologies can offer to a museum’s audience. Over the last few years, VR and AR have made huge strides around the globe, making people more aware of these technologies (TrendsWatch 2016). However, due to the high prices of the equipment, many people never get to experience either of these immersive medias. If a museum could offer a station with a VR headset or give out iPads for visitors to use as they explore the museum, then people would be able to experience these technologies for a small admission fee. William Deresiewicz argues in *The Atlantic* that people want more than just to see that great “thing”; people want to have a grand experience, an experience that visitors can enjoy with their friends and families. Nina Simon in her book *The Participatory Museum* also says that “As more people enjoy and become accustomed to participatory learning and entertainment experiences, they want to do more than just “attend” cultural events and institutions” (Simon 2010). VR and AR could be that experience for many museum attendees especially because they have a major wow effect on people of all demographics. AR especially can allow people to share and connect with one another. AR can allow for social conversation around the content of the interactive experience.

VR and AR also allow institutions to enhance the artifacts and art in their collections. VR allows visitors to get an immersive 360-degree view of the whole object compared to seeing an artifact in one location up against a wall (Center for the Future of Museums 2016). VR and AR can also enhance learning about the artifacts or other components of a museum. By allowing visitors to be fully immersed in the art and objects, they will understand more of the information the museum is trying to present. Sarah Kenderdine created a traveling immersive exhibit that
uses a headset to immerse visitors in the Magao Caves of China. These caves can no longer be
viewed by the public, but Kenderdine’s project, “Pure Land,” allows people to see the caves
exactly as if they were standing in them. To enhance this experience, Kenderdine programs
animation that allows viewers to learn about the images on the cave. A harp plays and moves
when visitors look over a picture of a harp that exists in the cave. This allows visitors to learn
about what a harp from that era would sound like. In another scenario, live dancers are filmed
and overlaid on top of these cave walls to teach visitors what dances might look like in ancient
Chinese culture (Kenderdine 2013).

The final major benefit is that this technology allows the museum to preserve, maintain,
document, and exhibit its collection. By digitizing the collection, the museum can analyze and
learn from the artifact without damaging it. This will help to preserve the artifact or object by
allowing it to be touched by fewer people and saved permanently. Digitizing the object also
allows the museum to have high-resolution documentation of the object. This could be used in
case of deaccessioning or damage. The documentation could also be accessible to the public for
educational purposes.

Preservation is always on the minds of conservators; technology can be used not only to
preserve artifacts, but entire historical sites. In the case of “Pure Land,” Kenderdine aims to
preserve caves in China that are thousands of years old that are wearing down due to mass
tourism and climate change. Preservation was also on the minds of the people at The National
Museum of Natural History. NMNH digitized their collection of bones that were in the museum
for over 50 years. Museum staff did not want to move or relocate the bones, because they had
been in that exhibition for a long time. Once the staff made the collection available online, they
allowed people to use their mobile device to access the collection (Marques and Costello 2015). They can access it using the Skin and Bones app that will be discussed further in a later section.

Museums have found a variety of solutions for issues where bones or artifacts are so old that they are hard to transport or examine. One solution that has been used for years is creating a reproduction. The museum would have the bones on display in a case, but outside the case is a model that can be touched or viewed by visitors. AR and VR are more advanced, 21st century, solutions that wasn’t possible until more recently. These technologies can allow for a deeper and more meaningful understanding of the art or artifacts.

**Limitations of AR and VR**

While technology is also innovative and creative, it has its consequences as well. One of the limitations that AR and VR have is the price of the hardware. As mentioned above, VR and AR headsets along with their accessories can become very expensive. The technology itself can be upward of $1000 and that doesn’t include the cost to create the content. Many museums are non-profit and do not have the money to spend on technology like this. While many museums want to take advantage of all the benefits technology can offer, there is sometimes a cycle of funding and obsolescence. If it takes a long time to find the funding for a large project, it could be several years before an organization can get started on a new technologically advanced exhibit and at that point the technology might be out of date. One way to break this cycle, however, is keeping the technology simple and creating engaging content for the viewers.

One of VR’s weaknesses is that it can cause motion sickness. In virtual reality, users are completely cut off from the real world. Depending on the type of application, some viewers can get nauseous or motion sickness from any movement happening inside the virtual world. This
happens because there is a missing connection between two or more senses that help people to stay balanced. VR can be a seated or standing experience. Many times, the digital space is moving around you, but your body is still. If the content in the VR headset is too fast then your body is receiving conflicting information on different sensory channels (Mason 2017). This causes the motion sickness that I, and many others, experience when using VR. There are many games where you see yourself moving, but your body is still, which gets people sick and makes the experience unenjoyable (Roussou n.d.). By contrast, AR allows users to see the real world but overlays digital information. This prevents people from getting motion sickness. Although motion sickness is a major limitation, technology specialists are always working to find solutions to issues such as this.

The last few weaknesses of both VR and AR are the actual glitches some of the hardware and software have, and the availability of technical support when needed. For example, if one of the headgears breaks then the organization must have an IT staff member capable of fixing these technologies, be able to send the equipment back to the company or a third party, or be able to afford a new headgear. At the British Museum, a case study mentioned that the application they were using with children was very slow, because it ran on the Wi-Fi of the museum. The app worked best the closer they were to the Wi-Fi, but became weaker as they moved through the museum (Mannion 2012). This is just one example of a technical malfunction that VR and AR applications can face. Even though poor internet is a common issue, multiple Wi-Fi connections or other more advanced hardware could help determine a visitor’s location and improve an indoor Wi-Fi based app. That means that museums would have to spend more money on Wi-Fi routers and other various technology to support the extended internet connection (Simonite 2015). Another software glitch with AR, is that if you are using a marker based AR app – where
your phone must be pointed at a marker to activate the digital layer of information- and if someone walks in front of your device the image or video disappears and may not always re-load properly.

How Museums are Currently Using Immersive Media

There are many examples of museums that have or are currently using immersive media in the museum. Scanning is a popular example of how AR is used in museums all over the world. Scanning is done using an app on a tablet or smartphone and holding the app up to a painting or object. The museum can set virtual markers on a painting or around the building for the phone app to recognize. When a marker is recognized then digital augmented elements will appear on the screen. The digital augmented feature could produce anything such as more text about the painting, a picture of the artist, or even a video or animation. The British Museum led visitors on a trail that allows them to scan AR markers with their phones that would give them clues of a puzzle they would have to solve. This scavenger hunt like game allowed visitors to explore more of the galleries in the museum (Mannion 2012). Scanning with AR is also performed at the Cleveland Museum of Art. Visitors can use their phones or rent an iPad that allows them to scan their favorite artworks, and digital graphics of text will show up to help educate the viewer about the painting (Alexander 2014).
Museums across the world are building apps themselves or working with third party companies to assist with the creation of immersive media programs. CEO Jim Cortina of Cortina Productions, a technology and new media company, worked with the LBJ Presidential Library to bring AR to visitors. Cortina says, “Augmented reality… is an opportunity for unique, multi-dimensional experiences in museums and presidential libraries that can bring to life static artifacts while also activating content that isn't readily available to visitors. Because the content surrounds you in the physical space, we are able to create stories that are real in scale and that can expand a visitor's understanding of the educational content they are seeing. It is also fantastic for these types of spaces because it continues to allow visitors to interact with each other to enhance and preserve the communal spirit that is inherent in museums” (Kite-Powell 2017). As
mentioned before, The Cleveland Museum of Art created an app to immerse visitors in its art collection. As pictured above, the app allowed people to scan various paintings to learn more information.

Museums in the UK and Australia are combining augmented reality with archival photography. In London, the Museum of London created an app where people can use their phone to see what the streets of London looked like years ago. People can look at what the streets looked like from the 1600’s into the 1960’s. Powerhouse Museum in Sydney, Australia offers a similar concept for the streets of Sydney. While the Netherlands Architecture Institute developed an app that lets people see buildings of the past, present, and what the future could look like in the cities of Rotterdam and Amsterdam (MuseumNext 2011). All three of these apps combine archival photography and some digital architecture elements in an AR app.

There are many different reasons for museums to invest in or consider bringing in VR or AR programs into their organization. AR and VR help to enhance the viewer’s personal experience at the museum by allowing them to interpret the collection on their own. Immersive media can also create a wow factor for museums. The “wow” factor can create an experience that could draw people into the museum and increase attendance (Deresiewicz 2015). Many museums also use this technology to educate visitors on their collection. I believe immersing children in the collections and artifacts will allow them to have more fun and help them to retain the information. The focus of my research was on how this technology can be used specifically for the education of visitors in museums.
How People Can Learn Through Immersive Media

School systems and lesson plans are beginning to use curriculum that incorporates immersive media to help engage the students in an educational experience. The US Department of Education, Massachusetts Institute of Technology (MIT), and the University of Wisconsin at Madison came together to create an AR app that allows students to go outside and learn specifically about math, language arts, and scientific literacy. This study was performed in 2009 on middle school and high school students. Students left the classroom space to work in teams using an app developed by the various university students called “Alien Contact.” Students could learn the various curriculum mentioned before and also learn how to communicate and work as a team (Dunleavy et al. 2009). Many schools and parents see cell phones as disruptive, but schools and museums can build apps that allow the students to engage their phones in a more positive educational way (Lenhart et al. 2010).

High schools are also creating other apps for students that use photography and video footage from Vietnam War protests that happened on their campus. Jim Matthews, a teacher at Middleton Alternative Senior High School in Wisconsin, developed an app called “Dow-Day” that allows students to put themselves in a real-world community context. The students walk around the University of Wisconsin at Madison campus while holding up their phones. The app uses GPS and QR codes so show students images or videos that appear of battles that occurred at their exact location on campus. There are also characters that can appear on screen as the students roam the campus. The characters can talk with students and exchange information and ideas. This idea then helps students develop a broader understanding of the topic which then allows them to create their own meaning (Jackson 2012). The projects mentioned above involve heavy planning of the budget and seeing the application through. An app like “Dow-Day” which
involves footage of Vietnam War protests involves heavy production of finding and possibly purchasing the videos for licensing. Projects can vary in production and price but should always be planned thoroughly. Although production and price can be high, educational outcomes like teamwork and history are very important.

Currently, VR is being designed into the curriculum at Washington Leadership Charter School in Washington D.C. The high school has a designated staff person to program and assist with VR and other types of technology in the classroom. The school believes that a tech-focused tool can help tailor the education more specifically to each student (Sahm 2016). Museums can take these concepts that schools use to help educate their students and apply it to their programming and collections. Museums could collaborate with the local school districts to incorporate lesson plans that relate to their mission. For example, a science museum could reach out to an astronomy class to invite them to their planetarium. From my experience in the field I believe many organizations already do this.

To summarize, AR is when a digital imagery is overlaid on top of the real world using a phone, tablet, or headset. On the other hand, VR does not allow the user to see the real world at all, instead, immersing viewers in a new digital environment. Two well-known examples of AR device applications are those like Pokémon Go and Snapchat. There are two popular VR headsets which are the HTC Vive and the Oculus Rift, although these are most currently being used for video games. The benefits of these technologies are for education purposes, preservation goals, and the overall “dazzle” or “wow” factor of VR and AR (Roussou n.d.) . The two primary limitations discussed are the overall cost of the equipment which includes the upkeep of technology, and the lack of available staff needed to keep tabs on the software and hardware.
Many museums are already using AR and VR to enhance their mission and the overall visitor experience. The Cleveland Museum of Art uses augmented scanning on their ArtLens app to enhance learning while the British Museum digitized their Bronze Age collection for a deeper experience (Alexander 2014). Finally, there are also many schools and Universities using immersive media as an educational tool. The University of Wisconsin at Madison has created an app for students to enrich their learning of history (Jackson 2012). This University also worked with the US Department of Education, and Massachusetts Institute of Technology (MIT) to create an app that allowed for group learning of various school topics (Lenhart et al. 2010). These are just a few examples of different types of institutions that use immersive media.

This question is important because, technology is always changing and there are always new games and technologies to become involved with. I believe AR and VR technology will help to create a memorable experience for visitors which will help them retain the information they learn and enjoy learning it. Guests want an experience when they go to a museum not just “the big thing” or a big name painting (Deresiewicz 2015). Immersive media technology can allow people to learn about “the big thing” in a new immersive and interactive way. AR and VR are also significant, because this attraction or experience could help to deepen a museum’s audience if marketed correctly. One of the top value propositions or benefits for museum visitors is that they want to learn more (Americans for the Arts, n.d.). AR and VR can help children learn more in the museum in a more interactive and engaging manner. Since 2008, the NEA reports that attendance at art venues is decreasing (National Endowment for the Arts 2015). Many museums are “rethinking the way visitors experience museums” (Erlick 2017). Sunil Iyengar from the NEA reports that “there’s a lot of competition for leisure activities” (Erlick 2017). AR or VR experiences could be a technology tool to help get more people interested in learning at
their local museum, which could help attendance and active learning an engagement with visitors.

**Thesis Statement**

I wanted to learn more about immersive media, because I wanted to discover how immersive media can be used to provide an interactive learning experience for museum visitors. I wanted to find out how museums can best use immersive media to educate their patrons. In this paper, immersive media encompasses both augmented reality (AR) and virtual reality (VR). Through my research, I have learned that although technology will always have that “wow” factor, technology should not just be implemented for technology’s sake. It is important to use technology as a means to an end or a solution to a problem. For example, if an organization has a conference room that is never used, then they could implement an immersive experience related to the mission and possibly charge extra for the experience. This would add the “wow” factor for visitors, add more to the museum exhibition by utilizing extra space, and even bring in revenue that wasn’t there before. The case studies I researched noticed a problem in their organization and brainstormed to find that immersive media was the solution.
CHAPTER 2- RESEARCH METHODOLOGY

For my thesis research, I completed a multiple case study of three uses of immersive media in museums and a case study of a company that makes immersive media experiences. The first case study will focus on an app called “Skin and Bones” that was developed by the National Museum of Natural History (NMNH) in Washington, DC. I downloaded the app and experienced the AR app while onsite to have a direct experience of how the app works and its potential to impact a visitor. Then I interviewed two staff members of NMNH. One is Diana Marques, scientific illustrator and animator, who is currently a Fellow at NMNH. The other is Robert Costeller, the National Outreach Program Manager. They implemented this app that includes augmented reality, educational media, and other imagery.

My second case study is the Franklin Institute in Philadelphia, PA. The Franklin has various VR experiences that visitors can take part in, in addition to a few AR interactives. I have been to the Franklin and used all the AR and VR tools they offer and will use my experience in this thesis. I spoke with Susan Poulton, who is the Chief Digital Officer, about the various immersive experiences that the Franklin has. I also spoke with Karen Elinich, the Director of Science Content and Learning Technologies. The Franklin has a lot of information on their website which I have used to inform parts of my research and the case study.

The third organization I examined was the Cleveland Museum of Art. I will consider the CMA’s ARTLENS Gallery which opened at the end of June 2017. The ARTLENS Gallery consists of four components: a studio, an interactive wall, an exhibition and an app. Although I was not able to view this exhibit in person I interviewed Jane Alexander, the Chief Information Officer.
The final case study I spoke to was a company that designs immersive media for arts and culture organizations called Night Kitchen Interactive based in Philadelphia, PA. Night Kitchen Interactive specifically designs apps, websites, and other interactive media for arts and culture organizations throughout the United States. Night Kitchen Interactive’s goal is to combine technology with design and storytelling to facilitate participation and learning (Night Kitchen Interactive 2017). They have developed media and interactive games for places like the Philadelphia Museum of Art (PMA), the Mütter Museum, the Smithsonian Institution, and many others. I spoke to Valentina Feldman who is a recent graduate of Drexel’s Master of Science in Digital Media. She wrote her thesis about how animating dinosaurs for VR can be used as an educational tool. Valentina is now an adjunct instructor teaching immersive media to undergraduates at Drexel University. I also interviewed Matthew Fisher who is the founder of the company. All participants have agreed to being recorded and are allowing me to quote them.

After completing this research and interviews for the four case studies, along with educational reading material, I thought I would find that museums can best use immersive media by creating apps that allow visitors to have a more hands-on experience with the museum collection. By using immersive media, museums can offer a more hands-on experience that children are less likely to have in a classroom setting or at home. The goal of having these technologies in museums is to have a more engaged learning and higher retention of knowledge. I found that the case studies were using AR and VR to help educate children to learn the museum’s collection and for visitor involvement. I discovered other factors that led museums to use AR or VR; such as for audience engagement and the overall visitor experience.

The significant limitations that I faced were finding museums using augmented and virtual reality. Cost is a major factor when dealing with AR or VR limiting the use in the
museum sector. Virtual reality will end up being more expensive, because museums will have to purchase actual headsets to be played on. Although with the new Hololens from Microsoft, AR can become expensive as well. Museums can use tablets or smartphones with mobile AR and would not need to have a bulky headset. For museums to get a third-party vendor to create content will be very expensive. The lack of content might also be a problem for many organizations. Content created by a company like Night Kitchen Interactive could be upward of $50,000 depending on the hardware and how immersive the client wants to create the experience (Fisher 2017). While sources at Cortina Productions inform me that costs for content creation can be greater than 1 million dollars. This leads me to believe that the largest obstacle to adoption will be the cost.

I found, through my research, various parts of my hypothesis to be true. It is important to allow visitors to have an experience when they go to a cultural organization. Technology assisted the various organizations by having an experience for people to come to. All the people I interviewed referred to AR and VR as experiences. Even further, Robert Costello at the National Museum of American History said their goal was “not to make an educational tool. It was more about the experience, and engaging experience” (Costello 2017). My hypothesis assumed the reason for implementing technology was to enhance learning and retention but I discovered it was not the focus after all. The goal of the organization was to enhance the museum collection by creating an experience for visitors. Then by creating an experience with technology, the visitors were able to learn more about the collection then they normally would have.
CHAPTER 3 - RESEARCH RESULTS

The National Museum of Natural History

The first case study was with the National Museum of Natural History using its augmented reality app “Skin and Bones”. This app was created for the Bones Hall in the museum. The Bones Hall was installed in 1911 with the opening of the building and then underwent a redesign in the 1960’s (Marques and Costello 2015). In fall of 2012, the museum decided to add a digital renovation by creating an augmented reality app that updated the hall without making any physical changes. I experienced this app for myself and spoke to two museum visitors about functionality and content.

When you open the app, there are numbers next to animals in a map style or it can list the animals that are featured. The numbers correspond to numbers on the wall next to the bones (see Figure 2).

Figure 2- An example of how the Skin and Bones screen is viewed when navigating the hall. This screen is a map of the different bones that are available to view on the app.
When you click on the animal in the app and then hold your smartphone camera up to the bones, it will augment your experience by placing digital skin on top of the bones you are viewing on your smartphone. Not every one of the almost 300 skeletons is augmented, but the museum made sure to represent each vertebra in the hallway. There are 13 animals featured in Skin and Bones, 9 of which have the augmented reality feature. The app does have audio which can be heard through headphones or with your tablet or phone speaker.

![Figure 3: An example of a museum visitor using the Skin and Bones app. The National Museum of Natural History captures a visitor using the Skin and Bones app on the swordfish skeleton.](image)

My initial thoughts after visiting were very positive. I experienced the “wow” factor as I have with many of my case studies. After getting over the amazement of it all, I did notice a few bugs in the app and other things that could be done better that were also noted when speaking with the other app users. For example, when we were looking at an animal that involved an animation and someone walked in front of the camera or the exhibit the AR animation would get cut off and glitch. Many times, I had to restart the whole video. The biggest benefit with this app is the “wow” factor. Both testers for this thesis said how “cool” the app was. One tester said,
“Seeing the bones and the animals move around, [such as] the bat crawling on the ground, was very informative and helpful. There is no other way I would have seen that without using this app” (Schmidt-Pauli 2017).

The major disappointment with this app for me was the lack of advertisement. There were no signs anywhere in the museum until you got to the hall. There were only 2 signs which were at either end of the hallway. I do not think this is an effective way to market such an incredible and unique experience. There is a website for the app, but you would have to plan your trip in advance and really look for it. While I was using the app at NMNH, a few 13-year-old girls noticed what I was doing and stopped to follow me. I showed them the app and let them use it. They loved the app. They were truly wowed at this AR experience. I directed them to the app and they each downloaded it on their phones. The girls stayed in the hall longer to use the app. If the museum advertised this incredible app, then more visitors could have the experience these girls had. Based on conversations with staff members and my experience using the app, NMNH is not actively promoting the Skin and Bones app. They have a website where you can learn more about the app at http://naturalhistory.si.edu/exhibits/bone-hall/. I believe this app has a lot of value to visitors from both visitor experience and educational stand points. I believe this is a missed opportunity in promoting a useful and engaging app. The app was published in 2015, so it is possible the organization was promoting the app actively that year and have since stopped. The National Museum of Natural History has a vast collection and in 2017 the focus might have moved on from the app developed almost 3 years ago.

Overall, this is a groundbreaking app from which other museums can learn elements to use in their own collections. There will always be bugs and improvements that can be made, but
the bugs in Skin and Bones did not detract from the experience for me. Compared to the other case studies, I think I learned the most from the Skin and Bones app.

The Franklin Institute

The next organization I researched was the VR and AR experiences at The Franklin Institute in Philadelphia, PA. The Franklin has various VR experiences placed in multiple locations in the museum which helps them to enhance their mission “to inspire a passion for learning about science and technology” (The Franklin Institute 2017). The main VR experiences are located on what they call the “holodeck”. In the “holodeck”, you can experience two high-end attractions; one of which is seated and takes you through the bloodstream wearing an Oculus Rift and the other is standing and lets you have an underwater encounter with a blue whale wearing the HTC Vive.

Figure 4- An image of the Holodeck at The Franklin Institute in Philadelphia. On the left, is a seated experience with an Oculus Rift. On the right, is a standing experience with the HTC Vive.
Then, there are two or three other VR carts that are “pop up” experiences. The carts have iPods with VR headsets that have changeable content. I experienced content in the space station area and in the brain portion of the Franklin. These videos can be referred to as “video VR” because the headsets just play 360 degree videos from the Franklin Institute’s app. The Franklin has an app that hosts 56 VR titles that can be played anywhere in the museum or at home using a Google Cardboard. To encourage people to download the app, the Franklin has about 12,000 Google Cardboard headsets that it can hand out to visitors. Unfortunately, the Franklin could not find a sponsor to buy 8,000 or more Google Cardboards for their visitors, so while the Franklin doesn’t give them out constantly, it does have them for special giveaways. Although the app is a very interesting component of the Franklin, this thesis focuses on learning and the experience in the museum. If you would like to find out more information about the app you can visit www.fi.com/app.

The AR that I could experience was done with a Kinect, a live motion sensor, and did not require a cellphone or tablet like other examples in this thesis. The first experience was walking into the Brain. When you walk into that section, a camera tracks you and maps your nervous system in front of you. The second AR experience was in a temporary exhibit called “Mirror Maze”. In “Mirror Maze”, a Kinect camera tracks and measures your body’s golden ratio. I will not be looking further into these AR experiences because my research focuses on devices that you can hold- like a smartphone or tablet.

After experiencing four VR experiences and two AR experiences at the Franklin, I was once again wowed. The VR on the holodeck was much superior to the ones in the pop up carts. The blue whale experience with the HTC Vive was my favorite of the VR experiences. Poulton mentioned that experience is the most popular with visitors because “It is a walking experience,
so the HTC Vive has hand controllers that you hold and you can actually walk around in a 10 by 10-foot space… When you are standing, your natural instinct is to turn your whole body. So, there is absolutely no doubt that the HTC Vive is more popular and the most popular and I would suspect it is because of that.” The fact that the HTC Vive allows visitors to move around and circle the space makes it more immersive and attractive to visitors. People’s normal reaction when seated is to stay seated and not move around. Because the audience is seated, users do not receive the full experience of VR.

The biggest limitation for me was when viewing the 360 degree videos in the space station and brain, I experienced extreme motion sickness in the middle of the video and could not wait to take the headset off. That is a major flaw that many people have noticed with VR as well. The HTC Vive and Oculus Rift did not make me feel motion sickness because I wasn’t moving or only moving slowly and could control where I could move. Normally, people experience motion sickness when using VR when multiple senses become unbalanced and disoriented. While I didn’t learn as much about blue whales or the blood stream as I learned with Skin and Bones, Poulton made it clear in my interview that, “Part of our mission is to inspire a passion about technology and learning… What we are doing right now is a technology experience. We are not trying to teach people about blue whales; the point is to have them learn about VR”. She goes on further to describe the holodeck: “The space is really meant to be a technology agnostic space, if we wanted to stick a Sony headset in there or a Hololens in there we could. It is really meant to be a virtual reality demonstration space. Where visitors, for free, can experience the latest and greatest VR technologies.” This shows how visitors are not meant to learn about the blood stream, but to get the exposure to VR that many people don’t have and learn about the technology itself. This is something very specific to the Franklin that may not be carried over
into other organizations. I think this experience is great exposure for people to test VR and hopefully they will want to experience more.

The Franklin Institute will open a new exhibit in the fall of 2017 which incorporates an AR app. The exhibit is called the *Terracotta Warriors of the First Emperor*. With help from The Pew Charitable Trusts, the Franklin created an AR app that tied together this exhibit. The Terracotta Warriors, when first buried in the ground over 2,000 years ago, each held some sort of object. These objects were made from wood and deteriorated. The Franklin saw a problem with the exhibit and used technology to enhance and fix the issue. The Franklin Institute took this as an opportunity to involve AR into the exhibit. Visitors can download the *Terracotta Warriors of the First Emperor* app and see what the soldiers would have been holding using AR technology. The Franklin wants visitors to know and learn about the objects that would have been in the warriors’ hands, but were not allowed to touch the statues (other than for basic curatorial purposes). The Franklin uses augmented reality to “enhance an experience that is hands off and missing pieces of the past” (Elinich 2017). Overall, the Franklin used AR to enhance an experience that is hands off and educates people on a piece of the past that has gone missing. This is a great example of something other organizations can implement. By adding a technology component of information that is augmented over an item already in place, museums can enhance a collection to make it more interactive without adding, moving, or changing the space.

I was able to experience the *Terracotta Warriors of the First Emperor* app for myself and spoke with three other museum visitors. Overall, the app was very interesting to use. I had a different idea in my head of how it was going to be. I thought you would be able to hold up the app to the actual figure and then the tool or weapon would be augmented in the figure’s hand. However, myself and other visitors were not told that you had to actually scan a QR code square
that was next to the figures. The first figure did not have this QR square and made me believe the app didn’t work. I observed many people having the same problem and become frustrated. Although it is great that other visitors knew about the app, the directions on how to use the app were unclear.

After figuring out how the app worked, I was able to see that the Franklin created a 3D rendering of the entire figure including what was missing from their hands. You could spin the rendering, zoom in and out, and click on educational hotspots for more information about the statue and its object. At first, I was disappointed that I couldn’t scan the figure and see what they were holding but then I realized this was a much cleaner way to create the app. By having multiple QR-like squares around the statue, many people could use the AR feature of the app at once without having a flow issue. If I had to be right in front of the statue, in a certain position, everyone would be fighting for space to see the AR component. I could zoom in and out of the figure and see more of its details no matter where I was standing. I could learn more than what was written on the plaques by clicking informative hotspots. After taking my time through the exhibit, and using the app on all the statues possible, I was very pleased with what I learned but thought the Franklin could have done more. One visitors said, “[The app] could have been more entertaining if they had walked around or marched. Or having them talk and say 'Here is how I use my bow and arrow” (Mauri 2017). She believes she could have learned more if the figures would have been animated in some way. They could have been animated to show how the archers would use their bows or how the entire army would have moved and acted together.

There are many ways the museum could have taken advantage of AR. The way the AR app is set up now was well advertised, designed, and I did not come across many technical issues.
Night Kitchen Interactive

The final case study was a company called Night Kitchen Interactive (NKI). The company has been working with museums and cultural institutions for 20 years “doing all sorts of work related to interactive and interpretation and interactive educational projects” (Fisher 2017). This tech and new media company has created interactive media exhibits for the Philadelphia Art Museum (PMA), the Academy of Natural Sciences, the Smithsonian Air and Space, and many others. Matt Fisher, the founder of the company, believes in the power of interactive storytelling and participatory engagement. Museums should be aware of companies such as Night Kitchen. Night Kitchen Interactive and other companies like it can help museums tell a story to their visitors using technology. The processes to develop these types of
technologies are very in-depth. Firms like NKI have technology and production skills that museums tend to lack due to budget and staff limitations. These companies are expensive and the more immersive and tech savvy the exhibit the more it will cost. With the high cost, comes the expertise of NKI that will greatly enhance the technical side of the exhibit as well as the storytelling and engagement side.
CHAPTER 4 – ANALYSIS AND DISCUSSION

The Experience

A pattern I observed in my interviews was that everyone spoke of the word “experience”. For example, Susan Poulton describes the virtual reality components at the Franklin by saying, “We have what we call the holodeck, which is downstairs, which has high end VR experiences. It has two experiences, the Oculus Rift and the HTC Vive right now.” In this example, she says “experience” twice when referring to the “holodeck” interactive VR space. I found this in all my other interviews. Matt from Night Kitchen Interactive describes his excitement about accessibility with AR and VR and says, “In more recent years, you can have VR experiences on your cellphone using Google Cardboard” (Fisher 2017). In my interview with NMNH, Costello and Marques take it even further by describing categories of experiences, “Some categories of experience that we looked at were social experiences, captivation, being attracted to the exhibition, surprise, awesomeness, and a few others” (Marques 2017).

The word experience is important, because it is something that VR and AR can add to a museum. Fisher and Feldman at NKI also mention other types of experiences such as the general museum experience. The museum experience is going to be different than an experience at a baseball game or the movies. The technology can be tailored to spread the museum experience onward by adding more engagement and more learning aspects. One of Night Kitchen Interactive’s goals is to, “use any kind of emerging technology to enrich a museum experience or…interpretive and educational goals” (Fisher 2017). This is important, because not only does this company support the museum experience, but they want to use technology to enhance it.

Social experience is another type of experience that is mentioned. Karen Elinich from the Franklin Institute states, “I believe learning in a museum is a social experience.” While Matt
Fisher from NKI also agrees, and expands on museums being a social experience by saying, “Some of the things that [museums do better than] the web and some other informal learning spaces… is that they are social. You tend to go to a museum or cultural institution with a cohort, people who, then, you engage with in ways that allow you to learn in ways you might not otherwise. So, [we wanted] to preserve that kind of real sweet spot for museums and cultural institutions of having social learning opportunities” (Fisher 2017). Immersive media can have both benefits and limitations to social learning experiences. One benefit of technology is that it can bring multiple people around a tablet or smartphone to interact with the exhibit. The challenge is creating content that supports social interaction on a mobile device, which is hard to accomplish. The down side of having VR and trying to encourage social learning is that VR is very personal. It involves one person with one headset that isolates the user. Poulton, however, firmly disagrees with this limitation. She says, “I have not seen [VR] to be as isolating as people claim it to be. And what is wrong with that? We do flight simulators, we do theaters; you don’t sit and talk with your buddies through a 25 minute IMAX, do you?” While I believe that people do learn from movies in museums, movies can be seen anywhere. If a museum is going to create an experience, specifically a social experience, they should be creating one that can only be seen or used in a museum that is driven by the mission of the organization.

This leads me to the final experience mentioned, which was the learning experience. Robert Costello says “The technology made [visitors] more aware of the exhibit, gave them another perspective of the exhibit by which to interpret the exhibit, and have the learning experience of their choice, rather than having a learning experience dictated by us”. This is unique because all types of museums can offer various types of learning experiences such as docent guides, films, live-action performers, and many others. However, immersive media can
allow for students or visitors to create their own learning experience that is curated by themselves. Though the museum organizes the app for guests, the visitor is making a learning experience that is catered towards their likes and dislikes. For example, a boy may use an app with his parents and only likes seeing the videos about reptiles. In this scenario, he is only learning about reptiles based off the videos provided by the museum. Another college student may come looking to use only the AR experiences and learn only about those few species, but gets a broader learning experience. This is different from the experience the boy has who gets a narrower education about reptiles, but receives more in-depth facts. Although they may not be getting all the information the museum provides, they aren’t forced to listen to a pre-recorded audio and they can pick and choose what they want to learn. The museum provides the content, but the viewer decides the direction what they want to learn.

Problem Solving

I also found in the research that many of the case studies implemented technology to help solve a problem. With the Franklin Institute’s exhibit the Terracotta Warriors of the First Emperor, the curators and educators were not permitted to touch the warriors in any way (other than to place them). Originally, the Terracotta Warriors all had something in their hands that has been lost to time. Karen Elinich explained the problem that FI’s curators and exhibition designers needed to solve. “Most of them were weapons, sometimes it was other objects, but they all had something with them that has been lost to time. For example, the General is resting his hands on a wooden sword. Well, that wooden sword is long since gone because wood does not stand the 2000 years underground- it deteriorates. So, could we as curators make a new wooden sword? Well in theory yes, but in practice absolutely not. By doing that, you are
attaching wood to this ancient pottery and that is bad practice from a museum curatorial perspective. So, we can’t make, in real space, a wooden sword, but what we can do in digital space is create a 3D model of that wooden sword. Using AR, you can hold your phone in front of the statue and see the replacement or recreation of what it looked like originally based on the archeologists’ understanding. The General’s sword will be digitally accessible through the AR component. The archers were holding wooden cross bows; through AR we are creating 3D models and placing those right in the position of where the hands are” (Elinich 2017). This solved a problem that could only be fixed using digital technology.

There was a different problem for the National Museum of Natural History. The Bones Hall is a permanent exhibit that has been untouched since it opened in the 1960’s. Costello noticed that people would not spend much time in this hall and wanted to fix this. He predicted this may be because the exhibit was older and the language was technical and hard to understand. Costello says, “[It] was clear to me that this was a historic hall and the challenge was to change the visitor experience without actually physically touching the hall. So, technology became the way to do that.” Costello needed to first define the problem: people not spending time in the hall and not understanding the ‘idiosyncratic text’ that was on the labels. Then coming up with a solution to fix these problems which was creating an augmented reality app. Skin and Bones allows people to take more time to look at the different bones in the hall. It also provides audio and visual components that are easy for all visitors to understand. Learning experiences like this one allow for more “time on task” which can help learning retention.
Time on Task

This section discusses “time on task” and how that type of engagement can relate to retention of learning. Time on task is explained by Karen Elinich by referring to it as the “holy grail” in the informal science educational environment. Elinich describes research she conducted with the University of Pennsylvania called ARIEL: Augmented Reality for Interpretive and Experiential Learning. Elinich summarizes her research results and says, “Completely across the board, no matter what else changed, the AR increased time on task. The phenomenon from a learning point of view [is that] kids tend to be hyped up and they tend to ping pong and run [around]. They don’t read the labels, they bounce around. So, the AR if it does nothing else, it increases time on task. Even if it is only a little bit, the longer the learner engages with the content the better… When the AR was turned on, the device was deepening their engagement because it gave them something to talk to each other about. They responded to what they did. Their behavior impacts how the AR appears, so they realized quickly and intuitively that ‘oh wait, when I did that then this digital animation appeared, what happens if we do this?’ They became more inquisitive, and it deepened their engagement” (Elinich 2017). Not only did this experiment increase time on task and allow for a better learning experience, but also created a social learning experience. The students worked together with the technology to complete tasks and learn more about science.

The Terracotta Warriors of the First Emperor app created time on task for a few of the visitors at the Franklin Institute. One visitor said, "[AR] gave me more interaction with the museum. I know whenever I go to museums... I look really quick and walk away. [AR] gave me a better appreciation of what was in front of me" (Mauri 2017). The AR feature in this app allowed this visitor to slow down and appreciate the artifacts around her. Another visitor also
said, "With the [AR] I spent more time there than I would have without it. With that time, I learned more than I would have" (N. Fisher 2017). The users took more time to scan the QR squares and play with the interactive that was available to them. This interaction allows them to take more time to read and learn about the history of the objects.

Time on task was also seen with Skin and Bones. When talking with museum visitors about the Bones Hall at the NMNH, one visitor said she, “remembered the bat crawling” (Schmidt-Pauli 2017). One reason that she remembered the movement of the bat species was because she could see it happening while using Skin and Bones. Using Skin and Bones allowed this guest to spend more time learning about the creature, therefore, remembering that animal even after leaving the museum.

Night Kitchen Interactive discusses their experience with an immersive app, Dreamscape, which was created for a hack-a-thon competition using the Philadelphia Museum of Art (PMA). Dreamscape allows users to examine the paintings at the PMA. Users would hold up an iPad and could move it over the paintings to see a 3D rendering of what the painting would look like. Then users could move the tablet around the museum space and it would reflect the style of painting they had just been exploring. The PMA’s front entrance could be painted in a post-impressionist style, or something similar. This app was successful in creating time on task because it created a deeper looking experience. “[Users] start examining more closely, they spent more time with the painting than they might otherwise. Maybe that is not the case with every visitor, but certainly certain visitors were engaging more and looking at more aspects of it. What we would find they would do is see something that we called out, [for example] pull forward in the plane in the depth of field, and they would then look back at the painting and see how the artist did that on a single flat canvas. What they are doing, is really understand or examine the
different techniques that the artist put in place to achieve the depth of field and the sense of perspective that they are putting on the canvas” (Fisher 2017). This app allows visitors to explore the diverse painting styles from different centuries and learn about these styles without having to be an art historian. The PMA houses so many different paintings it could be overwhelming for some. By creating an app like Dreamscape, people can use the app and take more time exploring the paintings and learning about the different painting styles (Dreamscape is not installed in the PMA, it was created for a competition and NKI used the PMA as a location for the app). Immersive media can provide new, interesting, social and engaging experiences that lets visitors spend more time learning about art, science, or history.

Further Limitations

While speaking to these various organizations, I have found more limitations of using immersive media in the museum. Many of the organizations also agreed with the limitations that were mentioned previously. The major limitation I addressed before, and that was supported in my research, was the high cost of creating immersive experiences. Fisher says that the most popular exhibits he creates are the “more immersive experiences. The tough thing with more immersive experiences is they tend to be more expensive, more costly. And they take up a fair amount of space.” This leads to one of the limitations I had not predicted which is that organizations need space. NMNH was lucky in that Skin and Bones was being created to enhance an exhibit that had its own space already.

NKI brought many limitations to my attention that I had not thought about before speaking with them. With VR, Fisher said a con for museums are “cooties”. Thousands of people and children go through museums and could use the VR headsets. Fisher cautioned me to
be careful about lice and dead bugs. Museums should know how to properly clean their equipment to keep it safe for all users. This can be done with anti-bacterial sprays or wipes. At the Franklin, the staff cleaned each headset with bacterial wipes which was reassuring.

An issue the Franklin deals with is “flow”. Poulton says that museums need to be careful, specifically with VR, because if the experience is too long they could have a line out the door causing issues with the flow of the museum and the experience. To avoid this, museums could add extra staff to help with the flow of the exhibit. There should also be extra staff to help members use the technology if it involves high end hardware like an HTC Vive. This could also an additional limitation because that means the organization must spend more money in hiring and training a comprehensive guest service staff team.

The museum industry also seems to be afraid of taking risks, which adding technology, like immersive media, can be. Poulton started her career off at AOL and brought her technology background into the museum world. From her stand point, the for-profit tech industry is used to risking half a million dollars even if it may not work out. Many museums do not have the luxury to take this risk which could hold them back. Museums do not want to spend money, or often don’t have the money, to spend on technology that is amazing now, but might not be in 5-10 years. The New Media Consortium, supports this by saying that one of the most significant challenges for museums in adding AR and VR components is that “Boards of Trustees and executive management too often do not recognize the importance of technology in generating financial or mission return on investment” (New Media Consortium 2011). There should be further research conducted to show how immersive media could bring in more visitors and increase ticket sales.
An important limitation for museums to recognize is that now-a-days kids and other visitors seem to have many choices in how to spend their leisure time. Fisher argues that kids are choosing the virtual experience over non-digital experiences. He states that “Museums can just continue to fill their spaces with non-digital experiences, and not augment those experiences, and continue -frankly- to see other venues attracting those visitors away from them. Or [museums] can see ways in which they can introduce those experiences in their spaces. Some [museums] get that 100%, many do in theory and then it becomes a matter of how. That is where, I think, new technologies that don’t require a lot of moving of or changing of the physical space are very attractive.” That new technology would refer to AR, where all the organization should do is create an app for their museum or an exhibit and market the new app to attract more children, students, families, or other targeted audiences. An AR app that augments a museum space also forces the visitors to come to the museum and have an experience they would not be able to have at home, at a sporting event, or any other leisure activity.

Valentina Feldman and Matt Fisher also think that although the technology has advanced enough to be used in the museum space the public may not be ready for it. Fisher shared a story where he describes how every time they do a VR demo with a client, the people that aren’t using the headset always pull out their phones to take pictures of the VR user to show them how silly they look. Feldman believes that people “gawk” at others using VR because, it is still so new and not fully integrated into the public’s everyday use.

The other major flaw Fisher brought up during our interview was that the technology could distract from the content, therefore distracting the user and taking away from its educational purposes. By adding more technology to an exhibit, the organization runs the possibility of users being more focused on the hardware and spectacle of the immersive media
than the content of the educational experience. I believe this can be avoided with content, quality
control, and the type of hardware being used in an exhibit. As mentioned before, an organization
should not just implement a VR station because it is “cool”. If the content does not match the
experience then the VR headset could distract from the content that is created. If a technology
project can be implemented with a cellphone or tablet, which the public is very used to, then it
will be less distracting for users. I think that technology bugs and glitches could also distract
from content which is why quality control (QC) should be performed at all stages of creating an
interactive. This will insure maximum usability. For example, Cortina Productions has a
dedicated quality assurance (QA) staff member that tests for bugs and glitches extensively to
ensure a smooth deployment of all games and software.

Further Benefits

While speaking to these various organizations, I have found other benefits of using
immersive media in the museum. Many of the organizations also supported the benefits that
myself, and others in the field also agree with. The biggest pro I found is the wow factor that
comes with technology like AR and VR. Poulton used words to describe VR like “amazing”,
“cool”, and “fun”. In talking with Feldman and Fisher, they used words such as “Ohh and Ahh”,
“excitement”, “thrilled”, and “spectacle” to describe how they see museum visitors and clients
talk about their products.

A benefit of having VR in the museum is its accessibility. Once there is more exposure to
the public, more people will know how to use VR and take more advantage of learning.
Museums are a great place for the exposure because if you go to test out the Oculus Rift or HTC
Vive at a Best Buy there is an age restriction. Poulton says “[Best Buy or Microsoft] have legal
restrictions that are 12 and older, mostly due to long term use to cover their butts. It is so you
don’t let your 7-year-old sit there in the basement with an HTC Vive for 9 hours, which would
be bad. [The Franklin] break[s] that down, so we allow all ages to experience those higher end
headsets along as their parent is present… To see a 7-year-old use the HTC Vive for the first
time is really fun” (Poulton 2017). Accessibility was a benefit that Feldman at NKI has been
seeing as well. She talks about the recent development of the Google Cardboard which allowed
more people to experience VR. She also mentioned that AR applications are getting easier to
create on their end making it cheaper and easier to bring content to museums. If the technology
keeps getting easier to develop, museums might be able to create an AR app in-house rather than
contracting a third party like NKI.

Overall, museum staff need to remember that although the mission may be to learn about
science, or develop a greater understanding for art or history, museum visitors want to be
entertained. They want to enjoy themselves with their family and friends. Costello from NMNH
said, “The way I think about it, is often educators get hung up on learning outcomes. To the
extent that they lose sight of the enjoyment of the experience” (Costello 2017). While the
learning outcomes and mission should never be forgotten, museums should embrace the fun
qualities that immersive media can have to help increase learning goals and enhance the total
museum experience.
CHAPTER 5 – CONCLUSION

After conducting seven interviews with four different organizations I have come to three different conclusions on how museums can best use immersive media to help educate visitors. The first major result I found was that organizations should not implement technology for technology’s sake. This means that if AR or VR is implemented into a museum, it should be mission driven and ultimately help solve a problem for the museum. Technology has the possibility to distract visitors, therefore, it should be used carefully. The second conclusion I found is that AR can allow for social learning which can increase time on task, therefore creating a more educational experience. Time on task can help museum visitors to retain more information from a museum whether it be about art, history, science, or another subject. The last inference I have come to is that visitors want to come to museums for an experience. They want to experience something that cannot be done at home. The technology allows visitors to gain access to technology they normally cannot. There are many types of experiences that a museum can arrange for its visitors like a social or learning experience. Museums have always been great social learning environments because of their social qualities. Usually, people attend exhibits with friends, family, dates, or even school field trips. This social learning allows for greater participation. Greater participation can lead to various outcomes for the institution such as attracting a new audience, collecting visitor-contributed content, and providing educational experiences (Simon 2010). By using AR and VR, the museum can enhance the social learning that is already taking place.

Once the organization has implemented an immersive media exhibit or app, the organization should work to make sure visitors are aware of the educational and experiential tool that has been created. Advertisements and websites can be created but the staff should also be
made aware of the technology implementation. The staff can let families and visitors know about the app or exhibit and invite them to use it. Getting the word out about the interactive experience could help enhance the visitors’ experience.

The use of technology should be added into museums to help benefit the mission of an organization and help increase attendance. Additionally, the key to a fun, interactive, engaging experience is strong content. Throughout this study, I have also discovered more limitations to AR and VR such as: controlling museum “flow”, possible spread of germs with VR, isolation of users and technology, and the fear that some board members or staff have towards using technology.

Museums should also learn from one another. Museums should address problems that they may be having and look at similar institutions to see if they could use technology to adapt one way or another. Then the organization can learn from the mistakes of another. If visitors complain about a slow Wi-Fi connection then another museum should know this and make sure that their Wi-Fi has extra equipment needed to prevent delays or outages. Instead of competing, museums can use each other as learning resources to improve their overall experience.

To conclude, I believe that museums should take risks to involve immersive media in their collection or exhibit. When there is a problem that is addressed, solutions involving technology should be brainstormed to see how the problem can be resolved. By incorporating AR and VR into a museum, the museum can allow for experiences that can only be featured on site and can intrigue audiences to visit. These technologies have the potential to make art and artifacts more fun and immersive. These interactive, immersive experiences could create a real night at the museum where the objects, artifacts, and paintings can come to life.
BIBLIOGRAPHY


