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Introduction

On March 10th, 2020, I received the news that my university was sending students home amidst concerns about COVID-19, an infectious disease that was officially declared a global pandemic. My senior thesis was among the many aspects of my life that were disrupted as a result of this decision. I had been working towards a project that illustrated the potential of participatory museum models and exploring how art museums could effectively leverage augmented reality (AR) for this purpose. Whereas museums have traditionally exercised a one-way delivery of content, the more contemporary participatory museum supports multi-directional content experiences. Under this model, a diverse range of visitor experiences are co-produced. The museum takes on the characteristics of a forum by inviting the public into conversations surrounding the museum and allowing them to help shape exhibitions, programs, and other activities (Simon 2010; Filippini Fantoni et al. 2014). Taking an approach that combines theory and practice, I developed an AR application for the Nasher Museum of Art and conducted an extensive literature review on participatory museums and the use of emerging technologies in museum spaces. SculptAR was designed to give museum visitors the opportunity to build their own virtual sculptures in the Nasher’s new Sculpture Garden. Through user testing, I sought to facilitate a participatory visitor experience that interrogated the role of the visitor and the museum in the 21st century and deepened our understanding of compelling uses of AR for

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1 World Health Organization, “Q&A On Coronaviruses (COVID-19).” COVID-19 is an infectious disease caused by coronavirus, which was discovered during an outbreak in Wuhan, China in December 2019.

2 Rouse, “What is Augmented Reality?” Augmented Reality is the overlaying of digital information in a user’s environment in real time.
museums. However, due to social distancing playing a key role in flattening the curve\textsuperscript{3} during a pandemic and the temporary closures of most art museums across the world, the testing of an application designed for a particular physical museum space was no longer a viable option for my research project.

While this initial approach was disrupted, a discussion with my advisor helped me realize that perhaps now more than ever, interrogating the museum experience and the relationship between the visitor and the museum would be invaluable and indeed timely. Art museums have traditionally emphasized and thrived on the value of the original. In his 1936 essay “The Work of Art in the Mechanical Reproduction,” philosopher and critical theorist, Walter Benjamin, describes this quality that original artworks possess as the aura. He maintains that,

“Even the most perfect reproduction of a work of art is lacking in one element: its presence in time and space, its unique existence at the place where it happens to be...

that which withers in the age of mechanical reproduction is the aura of the work of art.”

(Benjamin 1936)

In other words, a mechanically- or digitally-reproduced copy of an artwork will never inherit the essence of the original. This is why despite the fact that many well-known works of art can be found through a simple Google search, art enthusiasts will still travel from all over the world to see Leonardo da Vinci’s Mona Lisa in person. But we are currently facing a situation where museums worldwide have had to temporarily close their physical locations and their would-be visitors are sequestered in their homes. Experiencing the aura of the original is no longer possible and art museums are now forced to adapt to a climate where their only means of communicating with their audience is mediated through the digital.

\textsuperscript{3} Specktor, “Coronavirus: What is ‘flattening the curve,’ and will it work?” Flattening the curve refers to the community isolation efforts needed to slow the spread of the virus and keep the number of COVID-19 cases at a manageable level for hospitals.
The museum experience, if one exists at all at this time, is no longer bound to a specific site, space, or building. The museum visitor takes on a new meaning as they must traverse through cyberspace as opposed to geographic space to access cultural knowledge. And while art museums have implemented location-agnostic digital initiatives prior to this pandemic, COVID-19 has thrust these initiatives into the spotlight.

**Research Objectives**

This thesis will build the case for an alteration in how we perceive the art museum experience, emphasizing the value of the participatory and the virtual. To set the foundation of the traditional perspectives on art museums that I will be challenging, Chapter 1 recounts the elitist histories of these institutions, examines how their culture of exclusion manifests itself in the present day, and considers the extent to which art museums have evolved. In Chapter 2, I detail the relevance of the participatory museum model and consider whether and how it might be made manifest in art museums. In Chapter 3, I reflect on my experience developing an AR application for the Nasher Museum of Art and detail the potential of AR for cultural institutions. In Chapter 4, I examine what it means for an art museum to go virtual at a time like this by evaluating how art museums have previously engaged with virtual visitors, by documenting how they are now adjusting to this new reality brought on by COVID-19, and by exploring the potential of immersive technologies, such as AR, in providing engaging museum experiences regardless of a visitor’s location.

**Significance**
My research aims to expand on literature surrounding effective uses of AR. There are a limited number of museum studies and augmented reality research surrounding the best practices for implementing AR within a museum context (Marques and Costello 2018, 542). I address this through observations of and reflection on an AR application I developed for the Nasher Museum of Art.

Although COVID-19 has brought on a unique situation that prohibits the public, regardless of background, from going to a museum, some people face barriers in attending museums under normal circumstances. If museums care about reaching out to their broader communities, then cultivating experiences that draw a diverse range of visitors to the physical and virtual museum is crucial. Consequently, I argue that this is a crucial moment in time for art museum leadership to recognize the importance of virtual museum experiences and discover new ways for audiences to engage with their materials, regardless of their location.
Chapter 1: Expanding on the Elitist Roots of the American Art Museum

Art museums have a reputation for being elite institutions that distinguish between high and low culture. High culture is understood as “the best that has been thought and written in the world” (Williams 1974). In other words, it represents skills and works that are considered exemplary. Low culture, on the other hand, represents culture that appeals to a mass audience and is viewed as “lesser than” high culture. Art museums have perpetuated this differentiation and historically worked towards “separating artist from audience, culture from commerce, the tasteful from the tasteless” (DiMaggio 1987, 446). This authority that art museums have over defining what counts as high culture has impacted the ways that museums, visitors, and non-visitors view each other as well as the power relations between them.

An evaluation of the history of art museums in the United States can help us better understand this dynamic and give us the cultural context to understand why certain institutions de-prioritize participatory viewer experiences. Modern art museums were introduced to the US in the late nineteenth century. In contrast to European museums, American art museums were influenced by the country’s democratic ideals and made themselves open to the general public (Zolberg 1984, 381; Blau 1991, 89). However, their structure and governance privileged the upper class. Art for these museums, such as the Boston Museum of Fine Arts, came from privately collections whose rich owners could in turn influence artistic standards (David 1999, 322). In addition, upper class citizens provided early art museums with the majority of their funding and contacts. Their support came from a desire to cultivate a relationship between museums and high art, to distinguish high art from other forms of commercial entertainment, and to establish an elite culture. The openness of museums to the general public, on the one hand,

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and the power accumulated by the upper class through patronage on the other, contributed to the ongoing conflict between elitism and populism in the American art museum. While the wealthy elite, artists, scholars, and cultural entrepreneurs could actively participate in high culture and reinforce their social status, lower income communities were left out of the picture (Duncan 1965 cited in Zolberg 1984, 380-381). As trustees of these museums, rich patrons maintained that they were committed to the public and valued communitarian causes, such as education. However, the exclusive nature of high culture and lack of concerted action by trustees to engage the public demonstrated otherwise (Blau 1991, 90; Zolberg 1984, 385; David 1999, 323).

As time went on, classifying distinguished cultural activities and creating boundaries between the privileged and the rest of society became more difficult. Trustees had trouble cohesively defining the artistic tastes and activities that governed the culture meant to set them apart and the interests of the public gained a stronger influence in culture (Blau 1991, 91).

Meanwhile, art historians from universities and professional organizations forged connections with museums and therefore began to gain power in the 20th century. There was a new wave of curators marked by their academic backgrounds. Through professional associations and other external support systems, curators acquired funds through which they could purchase art as well as influence decisions made by art-collecting trustees (Zolberg 1984, 385-386). This period also saw a growing middle class who began to express interest in high culture (Blau 1991, 90).

Wealth played an integral role in the development of cultural institutions in the US. However, an educated middle class was needed to sustain them. Middle class interests helped legitimize museums as institutions, which then contributed to the increase in their number (Blau 1991, 91).

While this expansion of power is notable, it only represents the broadening of elitism to include academics. That is to say, museum power expanded to include both the wealthy and
those with advanced degrees. However, this still excluded different groups as one’s socio-economic status could heavily influence their opportunity to obtain the education necessary to be embraced by museum leadership. Outside of museum visitors who were motivated to learn about high art, scholarly curators expressed little interest in the general public. Museum education initiatives that engaged visitors received minimal funding and specialized personnel (Zolberg 1984, 386).

Art museums in the 20th century also continued to serve as cultural gatekeepers in their decisions about acquisitions. In 1942, Nelson D. Rockefeller, businessman and grandson of billionaire John D. Rockefeller, attempted to donate a collection of “primitive art”5, consisting of Mexican murals, Sumatran knives and blankets from the Inca city of Cuzco, and more, to the Metropolitan Museum of Art. The Met did not see artistic value in his collection and rejected his donation. Their director at the time, Herbert Winlock, recommended for him to reach out to the Museum of Natural History instead (Livingstone 2020).

As a result of this history, art museums in the United States have been linked to a culture of exclusion. The educated and wealthy elite determined what constituted high art and shaped artistic standards. Meanwhile, middle class visitors were denied a voice in developing this culture and were seen as less valuable investments, as evident through the lack of support for museum education. These founding principles still influence museums today. A 2019 research study conducted by reporters from the New York Times found that 40% of board members from America’s most attended art museums work in the finance industry or derive their wealth from it; they were also predominantly white. Their donations grant them access to exclusive cultural

5 “Primitivism and Primitive Art.” “The term “Primitive Art” is a rather vague (and unavoidably ethnocentric) description which refers to the cultural artifacts of “primitive” peoples - that is, those ethnic groups deemed to have a relatively low standard of technological development by Western standard.”
clubs, connections to artists and curators, and power. This has led art museums to be subject to critique. As Darren Walker, president of the Ford Foundation, put it, “We need to define trusteeship beyond people of financial wealth… Expand the number of board members and bring in people with other assets besides money that the museum needs. What’s interesting to me is the lack of energy, focus, and creativity to figure this out” (Pogrebin et. al 2019). People also still perceive museums as elite institutions, which may make them feel alienated and in turn affect their decision to enter these spaces. A 2019 study that explored non frequent visitor’s perception of art museums found that 52% of participants indicated that the ideal archetype of the museum visitor is privileged. This privilege was described as one that grants them the time and disposable income to attend museums frequently. In instances where participants brought up race, they connected the ideal museum visitor to being White and not a person of color (Claudio 2019). This study corroborates that the master narrative of elitism continues to structure the public’s understanding of art museums today (David 1999, 318).

Understanding this history – how it still shapes art museums and how they are perceived by the public – is useful for understanding how one might go about introducing participatory experiences driven by the public into this space. If art museum leadership has traditionally defined the art that belongs in museums, then granting the visitor input would indeed be something radical. AR within a museum context also conflicts with views of the museum as the authority. The purpose of AR is to overlay digital content on a real-world environment, which inherently affects how a visitor experiences their surroundings and consequently, how they derive meaning from those surroundings. This interjection in how a visitor sees the art that a curator selects represents a transfer of power to the technologist, which could be troubling to some museum leadership. On one hand, this could be a technologist that works with a museum to
towards an agreeable visitor experience. On the other, this technologist could be an unrelated third party. No one owns virtual space, and thus anyone with the resources and technical literacy could place virtual objects within a museum. Activists and art enthusiasts with the desire to shape the museum experience have taken advantage of this by creating unauthorized augmentations of exhibits. The Museum of Modern Art has been familiar to this form of intervention. The MoMAR Gallery application, developed by a group of renegade artists, alters the paintings found in the museum’s Jackson Pollock gallery through AR. When viewed in the application, the paintings become unrecognizable or replaced entirely (Katz 2018). Their website describes what they created as “an unauthorized gallery concept aimed at democratizing physical exhibition spaces, museums, and the curation of art within them” that “rethinks the mechanisms of art curation.” (MoMAR 2020) This adds nuance to a museum’s level of openness towards AR.

Moreover, the history of American art museums has marked the physical museum as the site of high culture. A virtual museum is not seen in the same exemplary manner. It is a digital copy that does not exude the same aura as the original. However, in the absence of a physical museum in the time of COVID-19, the virtual becomes the primary museum experience. In order to cultivate virtual museum experiences, it is important to question our ideas of what the virtual museum could be. Instead of using the virtual to reinforce or replicate the art museum experience, we should investigate what happens when we use the virtual as a site for innovation and experimentation of what the art museum experience could be. It does not have to make the traditional experience any less valid but opens it to new forms of engagement and new groups of people. This makes understanding the history of art museums useful as a point of interrogation.
Chapter 2: The Participatory Art Museum

If visitor participation in deciding on the art that goes into a museum is something that radically opposes the foundational history of art museums, why should an art museum consider promoting such practices in their institutions? To answer this question, I will use this chapter to point to cultural and economic patterns that demonstrate a desire for participatory experiences from a visitor’s perspective. In addition, I will help paint the picture of what a participatory art museum looks like.

The Museum Visitor in the 21st Century

American society is currently facing an experience economy. Coined by B. Joseph Pine II and James H. Gilmore in 1998, the experience economy recognizes experiences as distinct economic offerings. Pine and Gilmore observed the ways in which the commoditization of experiences was spreading beyond its traditional suspects, such as theaters and amusement parks. Consequently, they believed that experiences would serve as the next “competitive battleground” for companies (Pine II and Gilmore 1998). The impacts of the experience economy were illuminated through a 2017 study conducted by Eventbrite on the spending habits of millennials. The study showed that more than 3 in 4 millennials would rather spend their money on a desirable experience than a tangible item (Eventbrite 2017). Even though a museum visit qualifies as an experience, this experience, in the traditional sense, might not be as financially competitive today (Ballantyne and Uzzell 2011). Based on recent trends in American culture towards participation, cultivating a desirable experience in the art museum setting would ideally involve creating mechanisms for participation.
As noted in my introduction, the growth of social web technologies has increased the accessibility and pervasiveness of participation (Simon 2010). Henry Jenkins, American media scholar and Provost Professor of Communication, Journalism, and Cinematic Arts, refers to this phenomenon as participatory culture. He defines it as:

1. With relatively low barriers to artistic expression and civic engagement
2. With strong support for creating and sharing one's creations with others
3. With some type of informal mentorship whereby what is known by the most experienced is passed along to novices
4. Where members believe that their contributions matter
5. Where members feel some degree of social connection with one another (at the least they care what other people think about what they have created).

Not every member must contribute, but all must believe they are free to contribute when ready and that what they contribute will be appropriately valued. (Jenkins 2006)

In other words, people feel more emboldened to share their thoughts and content with the world and value platforms that enable their right to do so. This is observable through the high levels of engagement on participatory platforms such as Twitter, Facebook, and Instagram. Therefore, the growing ubiquity of participation drives interest in expanding it into previously non-participatory realms. The rise of citizen journalism and user produced content on the web demonstrates how this has already impacted the journalism and entertainment industry. While one could argue whether this has had positive or negative effects, the prevalence of these practices speaks to the participatory nature of the demographic contributing to them. In all, this shows that creating an avenue for participation in museums would be accepted by a significant portion of the American population.

This is also supported by research that has found casual visitors of museums to prefer exhibitions at complex-identity art museums. Dr. Shinwon Noh and Dr. Pamela S. Tolbert came to this conclusion after exploring complexity through the lens of comparing perceptions of art-only museums to art and science museums. While art critics preferred art museums with focused
identities, casual consumers enjoyed how complex-identity museums can satisfy a diverse range of tastes (Noh and Tolbert 2019, 105). I believe that their category-spanning definition of complex-identity could be expanded to include complexity of visitor experiences. Creating opportunities for participation in art museums can provide a range of options for ways that a visitor can engage with the museum, based on the extent to which they choose to participate. By including more choice in their experience, it can appeal to the same desire for experiences that account for diverse interests as highlighted in Noh and Tolbert’s study. Even though it is likely art critics and connoisseurs would not find this experience as appealing, I would argue that their viewpoints have historically been over-accounted for. It is time to take into consideration the perspectives of those museum stakeholders, the museum goers, who have previously been left out of the picture.

As Times Change, so must the Art Museum

Although museums still have some issues with elitism, the art museum has indeed evolved over time. This shift is revealed through how the definition of the museum has changed over time. In 1980, the Concise Oxford Dictionary defined the museum as a “building used for storing and exhibition of objects illustrating antiquities, natural history, arts, etc.” By 2010, the International Council of Museums amended this to “non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment.” (Ballantyne and Uzzell 2011, 2; Standing Committee for Museum Definition 2018, 3) This change reflects a growing prioritization of the public and the commitment of museums to their general education.
As evident by this expanded definition, art museums of the 21st century are looking for ways to create new learning opportunities and serve their broader communities. The role of the interpreter has been introduced to art museums as a position that acts as a bridge between curators and educators while keeping in mind the visitor’s perspective. From early stage conversations with curators to the design of the exhibitions, the interpreter considers how a visitor would experience the gallery space (Kotecki 2020). Furthermore, museum executives, during a 2011 study designed to understand performance indicators of museums, brought up innovation and the willingness to take risks as an area of importance for their institutions. As one interviewee explained, taking risks is necessary for museums in the pursuit of excellence (Zorloni 2010). Given the way that museums have been the ones to govern what is and isn’t included within their spaces, allowing visitors to have a say can be perceived as a risk. But based on the results of this interview, that risk is worth it in order to strive towards improvement and inclusion.

**Understanding the Nature of a Participatory Art Museum**

Before creating systems and structures that enable visitor interaction, it is useful to understand what a museum that values participation looks like. Traditionally, the primary way that museums engage with visitors is through providing content that visitors consume. Exhibits are designed in a manner that provides each visitor with a consistent experience. Incorporating participatory experiences into museums changes this dynamic. It disrupts the typically unidirectional flow of information from the institution to its visitors by promoting multidirectional content experiences. The institution presents a platform on which a diverse range of visitor experiences are co-produced and the visitors communicate, create, and share with one
another (Simon 2010). In a participatory museum, the relationship between the institution and the visitor is embodied through two-way communication, a dialogue between the institution and their communities. Contrary to the elitist models of the past, visitors are invited into conversations surrounding the future development of their museums (Filippini Fantoni et al. 2014).

Within an art museum context, one way this can be exemplified is through an education practice-based methodology called a/r/tography. A/r/tography acknowledges the ways in which the artist, the researcher, and the teacher (a/r/t) work in relation to one another. None of these identities take priority over the other. Instead, they simultaneously exist in time and space (Irwin et al. 2006). They are “reflective, reflexive, recursive”, and act as a rhizome\(^6\) (“A/r/tography” 2008, Artistic Intellect 2013). For example, the “Arts for Learning Art” project, a collaboration between the University of Granada and the Caja-Granada Memory of Andalusia Museum, is an example of visual a/r/tography. In this project, participants were given the opportunity to respond to a museum-exhibition installation visually. A piece of art was placed at the center of a wall and participants were encouraged to draw what they saw fit surrounding it, ultimately granting them power to alter the atmosphere of the space. The goal, as described by their researchers, “is that viewers learn to dialogue visually with original artwork, producing new images, which immediately become part of the installation.” (Roldan and Marin-Viadel 2014, 1-3) As a result, the exhibition space becomes a visual conversation in which the artist and the viewer are equally as relevant participants. In all, I find the rhizomatic nature a/r/tography to deviate from

\(^6\) IAAC, “Deleuze and Guattari – A Thousand Plateaus- The Concept of the Rhizome.” Deleuze and Guattari describe the rhizome as an “‘image of thought,’” based on the botanical rhizome”. It can be thought of as a network of roots that interweave, are multidirectional, and show no sign of stopping, creating a “complex unity”.

Redefining Visitor and Museum Roles through the Participatory

Enacting participatory experiences in the art museum changes traditional understandings of the museum’s role as elitist organizations. Visitors have been distanced from the art museum throughout time, from the literal structural barriers that minimize proximity to the art, to potentially burdensome entrance fees and inconvenient hours of operation, to a history that prevented low socio-economic communities from having a say in the development of American cultural institutions. Furthermore, the museum, even under the current iteration of its definition,
still promotes a one-way dissemination of knowledge. Building an inclusive participatory museum places value in the contributions and knowledge of a visitor, regardless of their background. If done genuinely, I believe that it could help contribute to dismantling elitism in the art museum and make these spaces more welcoming to all.

Moreover, new generations of potential visitors are growing up in a society that is vastly different from the society in which art museums in the US were first created. In order for museums to attract these younger and more diverse generations in a proliferating participatory culture, I find it important to question our perceptions of what a museum can and can’t be. An openness to experimentation with visitor participation could potentially lead to an enhanced visitor experience, education of both the visitor and the institution, and the inclusion of people who previously haven’t visited these institutions.
Chapter 3: Constructing Participatory Visitor Experiences Using Augmented Reality

One way to foster visitor participation is through leveraging interactive digital technologies, such as augmented reality. Augmented Reality (AR) overlays and spatially aligns computer-generated virtual elements onto a physical environment while still maintaining some view of the real world (Hornecker and Clofi 2019, 42-43). Because this spatial alignment occurs in real-time, it creates the illusion that virtual and physical elements share the same space as physical elements and interact with each other (Schmalstieg and Höllerer 2016).

Since the early 2000s, museums have been exploring ways to effectively incorporate AR into their institutions. AR was highlighted as one of the biggest trends in museums in the American Alliance of Museums Trendswatch 2016 (Dudzik 2018, 1). This is supported by studies that have found augmented exhibits to be linked to more positive visitor experiences and increased knowledge acquisition when compared to non-augmented exhibits (Sommerauer and Müller 2014, 67). But despite notable excitement surrounding this form of technology, it has not become commonplace and instead exists as a novelty item in many cases (Marques and Costello 2018, 541). This might be attributed to the challenges of using AR in museums, maintenance costs, and critique from some curators and museum staff. In a 2001 report by the Smithsonian institution council, they noted that “[b]ecause most museum staff began their careers out of a desire to have close contact with artwork, they may be reluctant to recognize that examples of high technology are themselves artifacts, and are often perceived as such by museum visitors.” (Smithsonian Institution 2001) In other words, museum staff at the time saw more value in tangible artifacts than they do in digital ones, making them more reluctant to implement ongoing initiatives that use such emerging technologies.
In an effort to better understand how museums could effectively leverage AR, I developed a mobile AR application for the Nasher Museum of Art. As a student pursuing an interdepartmental major in Computer Science and Visual & Media Studies, I was interested in taking an approach that combined both theory and practice. This interdisciplinary approach has roots in critical making, a process that blends critical thinking with physical making (Ratto 2011, 253). Its beginnings coincided with the emergence of maker culture, which promotes learning through doing (Craig 2015). Whereas engineering emphasizes efficiency and productivity, critical making emphasizes an understanding of humans, their perspectives, and cultural context (Hertz 2016). And although I am creating a product as opposed to a prototype and have thus had to also adopt engineering practices, I am still treating the development of this application as a site for reflection in the spirit of critical making (Hertz 2016). Understanding the cultural significance of creating a participatory AR museum application has played an important role in informing the development of my own.

This chapter will map out my process of developing an AR museum application. It will begin with documenting foundational research on AR in museums that I used to gain a sense of its current prevalence. This is followed by sections on my proposal process, application objectives, and the design and development of the application. Ending on a reflective note, I will address preliminary observations, limitations, and future directions of this application as well as what I learned about the potential of museum AR from this process.

The Challenges and Potential of AR in a Museum Setting

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Parts of the museum community have expressed doubt towards AR’s ability to produce desirable results. There are concerns regarding its gimmickry, visitor dissatisfaction with the onboarding and duration of the content, how it might detract from or replace the museum experience, how it could promote a heads-down experience, and how, especially for mobile devices, it can be isolating (Marques and Costello 2018, 542-545). In many cases, AR experiences involve using a phone or tablet device, which can come in conflict with a visitor’s desire to get away from screen-centered media at a museum.

In a Fall 2019 preliminary meeting I had with exhibit designers from the Life and Science Museum in Durham⁸, I noted concern that implementing AR would conflict with some of their museum’s values, which placed an emphasis on exploration, social interaction, and tangible materials. As a result, some questions that emerged from this meeting included: How could technology encourage exploration if software, at its core, is a set of finite rules? How could it foster in-person social interaction if you are confined to a screen? And what value would the digital add when this museum is committed to using authentic materials and believes in the tangible as the best means for learning? While they did note some successful examples of technology in museums that addressed these issues, they were rightfully still skeptical about bringing emerging technology into their museum. There were also concerns with regard to the maintenance of these technologies and the fact that technology can become out of date very quickly.

Shedding some light on the challenges that art museums in particular might face when it comes to AR, Dr. Julia McHugh, curator at the Nasher Museum of Art, communicated to me concerns surrounding the safety of their art. The hypothetical situation of a visitor getting

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⁸ This happened prior to my decision to focus my thesis on art museums.
distracted, becoming unaware of their surroundings, and causing harm to the art rightly causes
apprehension on the part of the museum staff. For example, a visitor who is focused on getting
the AR to work on their phone might bump into a display case behind them and damage what is
inside.

All of these concerns are important to consider because poorly designed AR applications
can detract from the visitor experience and cause visitors to have negative associations with AR
altogether. I experienced this firsthand at an art museum in San Diego. Embedded within their
general mobile museum application was an AR feature that “brought art to life.” When putting
selected art pieces into the camera’s field of view, the art would become animated. While this
was an interesting idea in concept, I faced several obstacles along the way that left me feeling
more frustrated than entertained. The application only worked on four art pieces in the entire
museum and did not specify where they were located. Unless a visitor were to remember the art
pieces from the application or notice an inconspicuous label to the right of the painting, it is very
easy to miss. As someone who enjoys roaming freely through a museum, I found having to
carefully examine each painting in the museum to find the compatible four to be tedious. By the
time I finally found one of the paintings and waited for the application to buffer, I was not
amazed by the animations. Overlays of two-dimensional lava exploding in the background of a
landscape painting and squiggles flying around an abstract painting, in my view, were not
transformative enough to add to my viewing experience. It left me regretful of downloading the
application and skeptical of how art museums view AR. It seemed to me that the museum
wanted to try out a new technology, but without putting too much thought into how to carry it
out successfully.
Despite these challenges, I still believe that AR has potential if it is done right. Robert
Costello of the Smithsonian and visual science communicator Diana Marques argue that “AR
needs to be a solution to the visitor experience by effectively weaving the virtual with the
physical into the narrative and ensuring that the interface becomes an integral layer, a
storytelling tool.” (Marques and Costello 2018) AR does not inherently hold value. Instead the
value is produced through how it is designed. In all, technology should not be used in museums
for technology’s sake. Rather, it should have a well-defined purpose (Trant 1995). When AR has
a purpose, it can create engaging experiences for visitors. Felicia Ingram, Manager of
Interpretation at the North Carolina Museum of Art, highlighted this potential in a conversation I
had with her. She expressed that visitors increasingly come to museums seeking an experience as
opposed to viewing a particular art piece. And on the other hand, museums are wanting to create
experiences that visitors will tell their friends about (Ingram 2020). AR has the power to
construct these experiences.

Proposing AR to an Art Museum

After understanding the challenges and prevalence of AR in the art museum, I met with
Dr. Julia McHugh of the Nasher Museum of Art. The goal of the meeting was to begin
discussions on the potential of developing an AR application for their museum. Wanting this to
be a collaborative process and to create an application that held value, I came to the museum
without any specific ideas. However, I had an understanding of how other museums have
leveraged AR and was ready to brainstorm based on the needs and values of the Nasher. What
became clear through our discussion was the importance of protecting the safety of the art and
the challenge of working with art pieces that are only at the museum temporarily. I found that
developing an AR application for one of their indoor temporary exhibits would be difficult to
receive approval for. This led to my suggestion of creating an AR experience for their outdoor Sculpture Garden, to which Dr. McHugh responded positively.

The Nasher unveiled its Sculpture Garden this past September. With only one sculpture in place by the time of this meeting, the space existed as a mostly empty landscape. Before it was populated with physical sculptures, I saw potential in using this space in conjunction with virtually augmented objects to foster exploration of this garden during this unique transitional phase. My idea was to develop an AR application that would enable users to build their own sculptures in this space. Ideally, users would be able to view their creations as well as the creations made by others as they navigate the space. As a result, the garden would be populated by virtual sculptures made by museum goers. Users would also be able to use this application at other locations outside of the garden to provide more incentive to download the app.

After submitting a proposal, this concept was approved by the Nasher Museum of Art.

**Application Objectives**

This application had three primary goals. The first was to allow visitors to feel more connected to the museum experience by seeing a reflection of themselves and their creativity in this space. In the vein of multidirectional content experiences, I wanted this application to embody the participatory museum model and prompt reflection on the role of the visitor in museums (passive viewer versus active agent, individual vs collaborator, etc.). The second goal was to enable physical exploration of the Sculpture Garden space. In an effort to counteract the heads down mobile experience, I wanted to incorporate the physical as much as possible to encourage visitors to move around. Thirdly, I wanted this application to foster in-person social interaction between visitors as they interact with each other's sculptures. Pokémon GO, one of
the most commonly known examples of AR, has been lauded for how it encourages collocated social interaction between players (Paasovaara 2017, 152). I wanted to achieve something similar but translate it to the museum setting.

**Designing and Developing a Participatory AR Museum Application**

*Design Process*

The first design decision happened prior to my proposal submission. I considered three display types of AR: 1) head-worn, 2) handheld, 3) and spatial. The first involves wearing a headset such as the Microsoft Hololens or the Magic Leap. The second uses mobile devices, such as smartphones or tablets. The third involves projection and holographic techniques. For the purposes of this application, I decided on a handheld display since smartphones are ubiquitous and it would allow users to use the application anywhere.

During the prototyping phase, I visualized the key functionalities of the application. The most urgent decision was figuring out the best method for users to build sculptures in AR. A mobile device has limited real estate, so I found it necessary that the building space extended into the real world. With that in mind, I found the most user-friendly method of doing this to be placing down and stacking blocks in their environment, in a style inspired by Minecraft. I also envisioned a save feature that would enable users to either save their project to a particular location or to a gallery.

During this phase, I settled on the name, SculptAR. It is a play on the word sculpture but pronounced “sculpt-A-R”.

*Technology*

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9 Minecraft is a video game where users can build and explore a procedurally-generated 3D world consisting of blocks
SculptAR is an iOS application that was developed using XCode, Unity, and Unity’s AR Foundation Framework. AR Foundation allows developers to work with augmented reality in Unity. It supports features such as raycasting, hit-testing, and plane detection, which are essential for the block building capabilities of the application. For the scripting process, I used one of Unity’s main programming languages, C#.

User Experience and User Interface

SculptAR was designed to give museum visitors the power to intuitively build their own virtual sculptures in the Nasher Museum of Art’s Sculpture Garden. After clicking the “Create” button on the home page (Figure 2), users are brought to the main sculpture building interface (Figure 3). In order for the application to recognize the ground that the sculpture will be built on, the user must move their phone around until a plane is detected and white dots appear on the surface (Figure 3).

The sculpt tool (Figure 3, Label A) allows users to add a building block to the scene and the delete tool (Figure 3, Label B) allows users to remove a building block from the scene. Building blocks are placed and removed based on where the reticle\(^\text{10}\) is pointed. Through raycasting and hit-testing, an invisible ray is emitted from the center of the phone and the application detects whether it hits the ground or another building block. If it hits the ground, then the building block is added to or removed from the ground (based on whether the sculpt or delete tool is clicked). If it hits another building block, then a building block is added to the face that the ray intersects.

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\(^{10}\) The reticle is the plus sign at the center of the user's screen that indicates where a block will be added or removed.
with or the block is removed altogether. The sidebar icons provide the following functionalities (Figure 3):

- Color button (Figure 3, Label C): Allows users to select the color of their building block
- Refresh button (Figure 3, Label D): Allows users to refresh their entire scene
- View button (Figure 3, Label E): Allows users to remove the obstructing UI elements from their scene to get a better view of their sculptures

Using a combination of the tools listed above, users are able to unleash their creativity and create their own digital sculptures.

Figure 3 – SculptAR iPhone screen capture of building interface

Figure 4 – SculptAR iPhone screen capture of a snowman sculpture

Preliminary Observations
Prior to being sent home by my university due to COVID-19, I managed to have one of my friends test out an iteration of my application at the Nasher. She is a college student who has been to an art museum two to three times in the past year and had two prior experiences using AR. With SculptAR, she created two sculptures. The first wrote out “DUKE” and the other was a heart. When reflecting on this experience, she described the building process as familiar. It reminded her of Legos and Minecraft. This sense of familiarity and the geometric nature of the application's design made it easy for her to navigate how to place blocks where she wanted them. She enjoyed the playfulness that using the application elicited. While using it, she “had this moment where [she] felt like a kid playing with blocks again” and allowed her “inner kid to come out.” She also highlighted a benefit of AR as the technological medium, citing that, unlike VR, she did not feel dizzy while using it.

As for challenges, she expressed that it was difficult to plan out where to place the blocks in relation to each other to get the desired outcome. I experienced a similar issue when I used the application. Given that I am used to drawing flat images, translating an idea in my mind to a three-dimensional sculpture using blocks was difficult. There were also certain restrictions in using a cube as the primitive. However, this added challenge of having to figure out how to go about constructing my sculpture did make the experience feel more engaging.

I asked my friend about how she felt about building in the Sculpture Garden space. Given that the space was empty, she said it didn’t feel any different than building on a sidewalk because all she had to interact with was grass and the concrete. However, she pointed out that once there are more sculptures added, she could imagine people getting creative and building around them. She envisioned a sculpture that encouraged visitors to “fill in the blank” with their own creations, thus establishing an interaction between the visitor and the sculpture. She also thought it would
be a good idea for the sculptures to persist in the sculpture garden space and visitors could observe the space change over time.

Because one of the goals of this application was to promote physical exploration of the sculpture garden space, I observed my friend’s movements while using it. After realizing that the building process occurred in three-dimensional space, she learned that physical movement was required to add complexity to her sculpture. She would shift to the side and angle her body accordingly. Given the smaller scale and two-dimensionality, or single-columned composition, of her sculptures, her movements occurred in a confined area. It prompted my curiosity towards what sculpture designs would engage more physical movement. To test this out, I built a three-dimensional snowman using the application, which ended up requiring a larger area of space for me to walk around in than what I observed from my friend. It demonstrated the potential for this application to engage users with the environment around them.

Limitations, Shortcomings, and Future Direction

While I managed to create a minimally viable product, there were still some elements I would have wanted to accomplish if it weren’t for technical difficulties and time constraints. The main feature I would work towards next is adding a multiplayer option, as seen on the home page (Figure 2). I would like for the AR scene to be a space where multiple people could co-create at the same time. Users would be able to build sculptures together or just view each other as they create their own individual sculptures, facilitating a synchronized social AR experience. Unity had a project called UNet that provides a system for developers to build multiplayer games. It
has since been deprecated and I experienced difficulty finding a more relevant method of building multiplayer AR projects in Unity.

Object persistence is another area of interest for the future of SculptAR. As of now, the sculptures disappear once the application is closed. It would be useful to create a save feature that allows users to save their creations to a particular location that is viewable across sessions and viewable by others. There could also be another option that allows the user to save their sculpture altogether and place it in a different environment. This way, users would be able to carry and display their sculptures, regardless of where they are.

User testing, which wasn’t possible due to COVID-19 disruptions, would have been valuable for gaining user insights in addition to the feedback I received from my friend. Based on those results, there might have been aspects about the application I would change or ideas for ways it can improve that I haven’t even considered.

Although platforms make the process of building an AR app straightforward, the process of sharing an application with others isn’t. As someone who developed an application for iOS devices, I found that the only way to share it with others, outside of taking a screen recording, was to submit the application on Apple’s App Store. However, I experienced barriers in doing so. Right off the bat, a $99/year account for the Apple Developer Program is needed to attempt to submit an application to the App Store. I found it unfortunate that there did not seem to be any less costly alternatives.

Reflecting on my Experience Building an AR Museum Application

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11 “What Is Deprecation (in Software Development)? - Definition from Techopedia.” A deprecated feature is one that “should be avoided by users”, including developers.
This experience only opened my mind up more towards the world of possibility when it comes to AR in the museum space. I acknowledge that there are challenges and understand that technology should not be used for technology’s sake. However, the potential of AR makes the experimentation of finding valid use cases important. Here are my main takeaways from this project:

- *AR can encourage imaginative play:* My friend’s comment about SculptAR bringing out her inner kid stuck with me. It showed that AR has the potential to trigger a feeling of playfulness, regardless of age. A user can bring what exists in their mind into “real” life and use their imagination to alter the space surrounding them. While art museums haven’t traditionally been associated with play, an openness to offering playful interactives could make for an engaging museum experience.

- *AR can be transformative and democratic:* Similar to the “Arts for Learning Art” project mentioned in Chapter 2, SculptAR gives visitors the power to transform the atmosphere of the Sculpture Garden’s exhibition space. As a result, a user of this application simultaneously exists as a visitor, an artist, and a curator. They are a visitor in its literal sense, an artist in their creation of their sculptures, and a curator in their authority to determine the aesthetics of the exhibition environment. The museum space becomes democratized and inherits the multi-directional content experience of the participatory museum model. One could imagine taking this a step further by ingraining AR into the design of an exhibition space (such as my friend’s example of a sculpture that encouraged visitor interaction) as opposed to thinking of the ways AR can be leveraged after the space is already constructed.
• *AR can be social:* Unlike VR, AR still maintains a view of the physical environment. It opens up the opportunity to build collaborative AR scenes where users can interact with each other and have a shared experience in the real world.

As a result of these attributes, I believe that AR has the potential to drive innovative visitor experiences within art museums so as long as it remains a vehicle for a larger experience as opposed to a novelty acting as the experience itself. In the next chapter, I will address how digital technologies, such as AR, have the potential to engage visitors beyond the museum walls.
Chapter 4: Virtual Museums in the time of COVID-19 and Beyond

As a result of COVID-19, art museums across the world, including the Nasher Museum of Art, have had to close their doors. In an effort to maintain a presence while everyone is quarantined in their homes, the museum community has had to adapt to this unique situation and use different techniques to remain in touch with their audiences digitally. Without the physical, the museum experience is now entirely virtual. This brings into question how technologies such as AR might be of particular use during this time. In this chapter, I analyze how art museums have constructed virtual experiences at the time of COVID-19, interrogate the art museum experience through the lens incorporating the digital, and speculate how museums will value curating location-agnostic virtual experiences and using AR technologies post-coronavirus.

Adapting the Art Museum to a Global Pandemic

Art museums have leveraged a mix of strategies in adapting to these unprecedented circumstances. Prior to this pandemic, many museums already had digital content that visitors could explore from the comfort of their own homes. These projects have now taken center stage, providing ample room to understand their effectiveness and room for improvement. At the same time, art museums have also used this opportunity to create more digital content and experiment with different ways to engage their broader communities. This mix between promoting old content and creating new ones has constructed the current landscape for the virtual museum experience.

Because China was the first country to undergo this health crisis, they were the first to have to adapt to this unique circumstance. In a meeting held by their National Cultural Heritage Administration in late January, they emphasized the important role of culture in providing the
their citizens with comfort during such a challenging time (Whiddington 2020). They encouraged museums to remain active and leverage their digital resources to create online exhibitions. Accordingly, a special team was formed and charged with the task of communicating with Chinese museums and creating a website that listed their digital offerings (Wong 2020). Links to 100 online galleries and exhibitions can currently be found on China’s National Cultural Heritage Administration's website (国家文物局 (Translation from Google Translate: National Cultural Heritage Administration) 2020). Many use a series of 360° images to create the digital exhibition space. Visitors can traverse through the space through click walking, zoom in on artifacts, read labels, and look around. These platforms try to replicate the experience of a museum tour, but through the virtual environment. Other options allow users to view and interact with objects in 3D (Whiddington 2020).

As the virus spread to other countries, the broader global museum community had to figure out how their institutions would respond. The American Alliance of Museums published a webpage on “COVID-19 Resources & Information for the Museum Field.” The page outlines resources for handling the challenges brought on by COVID-19. It includes guides on financial relief, preparing for closures, using digital platforms to remain in touch with museum audiences, and more (American Alliance of Museums 2020). Their section on digital platforms stresses how now is a crucial time for museums to explore digital and remote methods of communicating with their audiences. According to the AAM, providing visitors with virtual experiences through online collections, virtual reality, 360° videos, and live streams are increasingly important for fostering this communication. The page includes links to webinars and articles that equip museums with strategies they could use to accomplish this (Ciecko 2020).
In addition to the resources created for institutions, there are resources for potential visitors. People who are seeking a cultural experience from their homes can find lists of virtual museum offerings by browsing their search engines. Many of these lists point to Google Arts and Culture, which has played a large role in digitizing and sharing museum content with the world for the past near decade. Created in 2011, it is an online platform that hosts high resolution images of artwork from their partner museums that users can access from the web or through their mobile application. Partner museums, such as the Museum of Modern Art, the Metropolitan Museum of Art, and the Musée d’Orsay, are able to upload content based on invitation only. Once invited, these institutions are allowed to maintain and upload new content to their page (Google 2020). The platform provides a multitude of options for users to interact with their artwork. In addition to online galleries where visitors can view digitized materials based on tags and a zoom in feature that allows visitors to take a closer look at paintings, there are more immersive options as well. In this application, one could teleport through 360° views of a museum, project a real size art piece right in front of them using AR, or experience a museum tour through VR. One of my favorite features is the Pocket Gallery, which is a full-scale virtual art exhibit that users could place into their environment and traverse through in AR. This application’s diverse array of options enables virtual visitors to scope out which form of interaction is most engaging to them. And due to the over 1500 museums who have uploaded content to the platform (St. Francis College Library 2020), virtual visitors can go from museum to museum without the constraint of distance.

The virtual visitor can also find information through art museum websites, which outline their digital offerings during this time. “The museum may be closed, we bring Vincent to you”, writes the Van Gogh Museum on their website. Their page dedicated to at-home activities
appeals to parents trying to find activities to entertain and educate their children while they're at home from school. It includes coloring pages, lesson plans, an application that allows users to take a closer look at Van Gogh’s paintings, and 360° museum views hosted on Google Arts and Cultures (Van Gogh Museum 2020).

Social media has proved to be useful in providing a platform for people to consume and for museums to share content. Museums, such as the Metropolitan Museum of Art, have uploaded tours to YouTube where users can experience their art and architecture as a 360° video or through virtual reality by placing their phone in Google cardboard12 (Met Museum 2020). The museum community on Twitter has leveraged the platform’s hashtag system to share content with the world in a unified space. By searching #MuseumFromHome, one can find museums sharing images and videos of their artwork, artifacts, and galleries. Some have also shared informational education videos pertaining to their museum’s collections. The hashtag was made popular on March 12, 2020 by @MuseumOfCityNY right as many public spaces in the United States began announcing their closed doors (Museum of the City of NY 2020). From then on, many museums have joined in and publicized the hashtag on their home pages.

Other notable hashtags that have emerged include #MuseumMomentofZen and #MuseiChiusiMuseiAperti. Also began by @MuseumOfCityNY, #MuseumMomentofZen encourages museums to post artwork that helps facilitate a calming environment during these times of uncertainty (Museum of the City of NY 2020). #MuseiChiusiMuseiAperti, which translates to “museums closed museums open”, is a hashtag in Italian that encourages museums to upload their content to Twitter. @museotattile_VA, the twitter account for the Museo Tattile Varese and creator of the hashtag, on February 24, 2020 tweeted:

12 Google Cardboard is a virtual reality platform developed by Google where users can insert their smartphones into a low-cost headset made out of cardboard
“Facciamo in modo che i nostri visitatori ci possano 'visitare' anche se siamo chiusi, mostrando o raccontando loro qualcosa di speciale? Che ne dite @MuseiRealiTo @MdR_Torino @MuseoNovecento @MuseoCentRom @DucaleVenezia @PalazzoDucaleMN @LaVenariaReale? #museichiusimuseiaperti” (Museo Tattile Varese 2020)

Translation:

“Let’s make sure that our visitors can 'visit' us even if we are closed, showing or telling them something special! What do you say @MuseiRealiTo @MdR_Torino @MuseoNovecento @MuseoCentRom @DucaleVenezia @PalazzoDucaleMN @LaVenariaReale? #museichiusimuseiaperti”

The hashtag carves out a digital space for museums and their communities to interact with each other. And while anyone can join in given the participatory nature of social media, the act of tagging other museums to join helped get the hashtag off the ground.

Art museums have understood the importance of supporting each other during such unprecedented times. Over 3,000 people from the global museum community tuned into a webinar hosted by Cuseum on, “How to Keep Your Audience Engaged, Entertained, and Inspired in the Age of Coronavirus.” Scott Stulen, Director & President of the Philbrook Museum of Art, Brandan Cieko, CEO & Founder of Cuseum, and Seema Rao, Deputy Director and Chief Experience Officer of the Akron Museum of Art, homed in on this point of comradery between museums during this session. Art museums are not competitors and should partner with each other, especially at a time like this. Ultimately, each museum is restricted by the amount of digital materials and resources that they collected prior to temporarily shutting down. However, there is still value in pointing their audience to resources offered by different museums. For instance, some museums have participated in social media swaps where museums take over each other’s social media accounts (Ciecko et al. 2020). Taking steps like these helps create a seemingly endless network of museum content for virtual visitors to enjoy.
In addition to fostering communication between museums, this situation has also promoted communication between museums and their audience. The North Carolina Museum of Art created NCMA Recommends, an initiative that highlights the people’s favorite art pieces. Community members are invited to fill out a survey about their favorite art pieces from the NCMA’s collections. After discerning the most popular artwork of the week, the NCMA shares content based on that artwork on their social media page (Ingram 2020).

**The Challenges and Potential of the Virtual Art Museum**

This transition to the virtual has not been without its challenges. As the threat of temporary closures became more real, some art museums scrambled to gather digital content from their museum before it was too late. Others encouraged museum staff to dig through their camera rolls for images and videos, in search for content (Ciecko et. al 2020). But ultimately, art museums are limited to the tools and digital materials they have at their disposal and the content they can create while social distancing. Thus, they’ve had to be creative in how they provide avenues of engagement for virtual visitors.

In discussions I had with Felicia Ingram and Michelle Harrell, Director of Education at the NCMA, both brought to my attention some of the other challenges museums face when connecting with their visitors at a time like this. Access to technology has proved to be one of them. There are some visitors, especially in more rural areas, who do not have access to the internet. Unable to engage digitally, their museum has had to brainstorm other forms of engagement through physical mail. Another challenge is the still persisting desire to refrain from the overuse of screen-based media. Under ordinary circumstances, some visitors attend museums for relief from their software mediated lives. Replicating this experience is now difficult, as
screens play an important role in facilitating communication between the museum and their visitors. However, Harrell expressed to me that their museum is still trying to prioritize experiences that get them away from it. Ingram provided the example of sharing art activities that people could create with materials that could be found in their backyard (Ingram 2020, Harrell 2020).

Despite these challenges, this is a learning experience that has great potential for the future of art museums. “Right now, all the people who don’t come to museums, this is our chance to catch them,” says Rao in the Cuseum webinar mentioned above. She draws attention to the fact that the people who come to museums and are using virtual offerings can share it with their friends, growing the museum network further. Because of this, the opportunity to reach out to those who experience barriers in attending the physical museum presents itself. Furthermore, the experimentation that museums undergo now can turn into lasting initiatives that persist after this situation passes. Those who gain interest in museums now could either attend museums once they are open again or continue remaining engaged through the digital.

**Museum AR in the Time of COVID-19**

In addition to the challenges noted above, the absence of the aura in the virtual museum is one worth articulating. The notion of the aura has relegated digital copies of art to an inferior status. As a result of this, digital artwork on its own provokes a neutral response. It falls into the sea of images we observe every day on social media. Perhaps it garners a “like”, but it falls short to the level of interest one experiences when viewing art in person. To capture intrigue in the virtual museum, constructing immersive experiences are of increasing relevance. It is one thing to scroll through a website and another undergo an embodied interaction. By engaging the
physical body and using technology as an extension of that engagement, it disrupts the typical human-screen interactions we experience on a day to day basis. In the process of this disruption, it separates us from the circumstances that contribute to our neutrality towards the digital copy. This is where I see XR technologies, such as AR, playing an important role.

Going back to the Google Arts and Culture application, my favorite feature was the Pocket Gallery because of the embodied interaction it provided. Using this feature, one could drag and drop a full-scale virtual art exhibit onto the floor in front of them and traverse through it in AR. Unlike 360° museum tours, the Pocket Gallery is not based on any existing real-world museum space. The gallery is entirely virtual and the paintings inside come from museums across the world. Once the exhibit is placed down, a user could physically walk through the space or, if in a more restricted environment, move around seamlessly using their touch screen. I find this method of the virtual museum to be more effective than 360° tours where teleportation makes movement choppy and the use of 360° still images makes salient the fact that what you’re in is just a copy, and thus inferior to the real thing. The Pocket Gallery does not encounter this same issue of comparison and can exist as its own location-agnostic entity. Furthermore, it harnesses the power of the digital in bringing together materials that physically exist in different places. AR in this context also has the potential to break from the typical two-dimensional image gallery experience we have on social media. The simulation of a three-dimensional gallery space can facilitate a connotation of aesthetic value towards the artworks displayed.

At a time where museums are temporarily closed, AR has the potential to provide an engaging cultural experience, regardless of where a user is located. The ubiquity of mobile

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13 North of 41, “What really is the difference between AR / MR / VR / XR ?” XR, or extended reality, refers to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. It is an umbrella term for augmented reality (AR), virtual reality (VR), and mixed reality (MR)
devices makes AR accessible to a wide audience. Therefore, for those with the technical resources and bandwidth, now presents an opportunity for experimentation with the medium that is useful both now and post-coronavirus.

**The Virtual Visitor and the Virtual Art Museum Experience**

The Virtual Museum Transnational Network provides a useful framework for understanding the virtual museum. According to their report on this topic,

> the core function of a VM can be loosely described as a location of rich content – often reflecting unique and precious objects or works of art – collections that have been assembled and displayed, yet in contrast to their physical counterparts, once liberated from their materiality are poised to open up new potential for novel kinds of experiences. (Hazan et al. 2014, 34)

This “liberation of materiality” frees the virtual museum from restrictions imposed by physical space. Without spatial boundaries, capacity is no longer an issue. As many people as the internet bandwidth allows can simultaneously experience the virtual museum. The virtual museum has no hours of operation or entrance fees. The democratic nature of the internet allows anyone with access the ability to participate. In addition, the participatory nature of the virtual museum in conjunction with the absence of the physical museum could help absolve some of the elitist connotations that art museums present. Elitism is weakened by the fact that the virtual museum does not exist without visitor participation or without museums working together. Whereas the traditional art museum has managed to exist without the participatory, the virtual art museum is a relatively newer system where museums and virtual visitors work together towards shaping the virtual landscape. The virtual museum isn’t singular. In the time of COVID-19, it has become evident that the virtual museum is a network of museums across the world. It is difficult for any single museum to offer all of the possible digital offerings that exist. So instead of re-inventing
the wheel, museums share each other's content, share tutorials, and support one another. In all, the virtual visitor and the museum are encouraged to communicate between and amongst each other within the virtual museum.

A similar liberating effect also happens in absence of physical objects. Through techniques such as digital photography, 3D scanning, and photogrammetry, a physical object is used to create a digital counterpart. These digital objects allow the virtual visitor to take a closer look at artifacts they might not otherwise have access to. Furthermore, it allows for physical objects that are separated by geographic locations to exist in proximity to each other in virtual space. Consequently, experiences that are impossible to replicate in our real-world can now be created in the virtual world.

The virtual museum does not have to be grounded in any physical object or physical location at all. When we detach ourselves from the desire to create virtual experiences that mimic physical experiences, there is potential to create the “novel kinds of experiences” that the Virtual Museum Transnational Network refers to in their description of the virtual museum. This is why I believe I felt captivated by Google’s Pocket Gallery, which immersed me in a space that doesn’t have a physical counterpart and was thus inherently novel. This perspective might also lead to even more innovative experiences that will take time to ideate and make a reality. Nina Simon, author of *The Participatory Museum* and founder of the non-profit OF/BY/FORALL, recently wrote an article that touched on what cultural organizations could do at a time like this. While unopposed to the “deluge of virtual museum tours, live-streamed opera performances, and digital educational resources,” she prompts us to reflect on whether this current direction is the most meaningful way cultural organizations can contribute to this crisis, or the fastest. She asserts that moving slowly at a time of uncertainty could lead to creative initiatives that are not
obvious to us right now (Simon 2020). Relating this back to the digital, perhaps the virtual museum as we currently understand it is only the tip of the iceberg in regard to its potential and the definition will continue to evolve and expand over time.

In the context of this current global health crisis, diminishing barriers and increasing accessibility to educational and cultural resources hold importance. The arts offer a special service in uplifting the spirits of our country during such challenging times. Accordingly, the museum’s goal of exhibiting “the tangible and intangible heritage of humanity” does not diminish in the absence of their physical building (Standing Committee for Museum Definition 2018, 3). The museum community has been working towards creating engaging, remote visitor experiences that will hopefully persist beyond this pandemic. This unprecedented situation has forced museums into trial and error that will provide the framework for future digital initiatives.
Chapter 5: Conclusion

The purpose of this thesis was to test the limits of what the art museum experience could be through the lens of participatory augmented reality and the virtual landscape of museums intensified by COVID-19. I had several motivations. The first being that those who have tried to implement AR in the museum have experienced challenges that have relegated the technology to existing as a novelty. Therefore, I set out to explore the underutilized potential of AR within the art museum through preliminary research, the development of a museum AR application, and my reflection on the process. My second motivation was a desire to understand what it means for a museum to go virtual during a global pandemic. Whereas the first part of my thesis challenged traditional art museums in a participatory sense, having to shut down the physical museum for an indeterminate amount of time forces another point of interrogation of that same status quo. Thirdly, I was motivated by wanting to discover ways that the art museum could be expanded to a broader audience, which was applicable to both portions of my thesis. Within the participatory AR section, I found that cultivating visitor participation could attract and engage the growing portion of our population who thrive on participation culture. As for the virtual museum, by removing the physical barrier of access to cultural content and knowledge, more communities are able to engage with art museums. Overall, these different motivations served towards countering elitist beliefs that still persist in art museums.

In the spirit of critical making, I combined both theory and practice in the process of developing a participatory mobile AR application for the Nasher Museum of Art. SculptAR was designed to give visitors the opportunity to build virtual sculptures in the museum’s physical sculpture garden. In the process of designing and developing the application, I learned the importance of not using AR for AR’s sake. AR should be used as a vehicle to make way for
engaging visitor experiences that could not otherwise exist without it. Within the context of SculptAR, the AR was not intended to be the spotlight of the application. Instead, the focus was on the experience of building a sculpture and viewing your own creations within the sculpture garden. My thesis was limited by the fact that I was not able to conduct user testing due to COVID-19 disruptions. But based on preliminary observations of myself and my friend using the application, I found that mobile AR can invoke playfulness, grant visitors the power to transform the atmosphere of an exhibition space, and facilitate in-person social interaction. Consequently, for art museums looking to drive innovative visitor experiences, AR has the potential to do so when used effectively.

In the age of COVID-19, art museums have had to adapt to a situation where the art museum experience exists exclusively through the virtual. Through Twitter hashtags, 360° museum tours, live streams, and more, art museums have exercised a range of digital offerings that have shaped this unprecedented virtual landscape. While only time can tell which methods prove most effective, I see potential in XR technologies, such as AR, in providing meaningful interactions between users and cultural content in the absence of the aura of the original. This unique time is also shaping our understanding of the virtual museum. I have found that in the time of COVID-19, the virtual museum is a network of cultural institutions and virtual visitors communicating amongst and between each other. The art museum community has leaned on each other for support in undergoing this transition. This virtual museum is also experimental and provides an avenue for trial and error that is not offered to the same degree within the physical museum. And lastly, it is liberating. The art museum experience does not have to be bound to a physical location or a physical object. And with that, the barriers typically associated with geographic location are no longer issues.
Altogether, this research suggests that traditional art museum experience is no longer effective for a wider audience who desires participation, has previously been turned off by the elitism of art museums, or has experienced barriers in attending museums. In fact, in the time of COVID-19, the traditional art museum experience isn’t even possible. It is important for us to continuously question our perceptions on what the art museum should and should not be as it adapts to the modern world. In doing so, interactive technologies such as AR could prove to be fundamental.


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Appendices

Appendix A: Screen Recording of a friend using SculptAR

https://www.youtube.com/watch?v=YQqDVMUHH_g

Appendix B: Screen Recording of me using SculptAR

https://www.youtube.com/watch?v=5h5kVeeqbvU

Appendix C: Homepage of SculptAR (multiplayer feature inactive)
Appendix D: Building Interface of SculptAR + plane recognition
Appendix E: SculptAR Color GUI
Appendix F: Sculpture in Progress using SculptAR (two different iterations of the app depicted)
Appendix G: Final Sculptures created using SculptAR (two different iterations of the app depicted)