Augmented Reality in Museums

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INTRODUCTION

"AR is an attractive medium for use in museums because digital databases challenge existing archives with obsolescence, and the ever-growing tide of digital information can be reconciled with traditional, physical databases through the promise of AR."

- Geoffrey Alan Rhodes, Filmmaker, Assistant Professor at School of the Art Institute of Chicago

AR (Augmented Reality), a technology that imposes layers of virtual content on the real environment, enables a smartphone or tablet user to aim the device at a designated point and watch a still scene come into life. The ubiquity of mobile devices use has provided the public great opportunities to get familiar with AR applications in various spheres. For museums, the appeal of AR is clear – the technology allows rich media content such as graphics, animations, and videos to be layered upon real environments, which provides a way for museums to bring collections to life.

The following research provides a view into AR technology and opportunities for its use in museums. To understand what kinds of AR applications are used in various types of museums in the United States, this report will first present the global trend of increasing AR use in museums and explore the benefits of using AR apps in museums' exhibition spaces. Three up-to-date case studies on the leading museums in the United States will show how to choose and make use of an appropriate type of AR app in a museum. The report concludes with some reflections and expectations regarding the future of AR in museums.

What is AR?

Augmented Reality, also known as AR, provides a live view of a real world environment with elements that are augmented by computer-generated images. Generally speaking, AR applications for smartphones usually include GPS (Global Positioning System) to pinpoint the user's location and detect device orientation by using the compass. Unlike Virtual Reality (VR), which provides an entire artificial environment, AR makes use of the existing environment and overlays new information on top of it. It blurs the line between the reality and the computer-generated information by enhancing what we see, hear, feel and smell.

Pokémon GO, the popular game released by Niantic Inc. in the summer of 2016, is a great example of how location-based AR has transformed the gaming experience. Not only AR has found its place in gaming – it also has become a novel medium that offers new layers of interpretation to museum collections. According to the 2012 Mobile in Museums study, 1% museums in the United States have started embarking on AR as a mobile feature.

AR and the Museums

According to the 2015 Trendwatch Report, digitally mediated personalization and personalized learning are two global prominent trends in museums in recent years. A majority of museums with over 50,000 on-site visitors are using new mobile-only technology. Through mobile apps, museums can provide supplemental information about an exhibit or the museum itself; or as a personalized mobile guide through the museum collection or gallery spaces.

As QR codes, mobile phone guided audio tours, and smartphone apps have become widely used mobile features in museums all over the world, some museums are starting to explore ways to weave in more interactive and customized features that can enhance visitor experience. Already on a path of convergence with mobile technology, AR has become a portable tool for discovery-based learning that can enhance the information available to patrons when visiting gallery spaces, interacting with real-world objects, or even exploring outdoor installations.

Over 1% of U.S. museums are embarking on AR as a mobile feature. A recent example of experimenting with location-based AR apps out of the museum space is the Chicago 00 Project, a partnership between the Chicago History Museum and filmmaker Geoffrey Alan Rhodes. "Chicago 00 The Eastland Disaster" app offers a customized AR

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tour. When the users walking along the Chicago Riverwalk between Clark and LaSalle Streets, with a VR Gallery of images that can be viewed anywhere, the story of the disaster will be revealed in a visceral way.

Other museums are experimenting with AR apps inside the gallery spaces. For museum visitors, AR apps on mobile devices are very easy to use. According to the 2014 Digital Revolution report, 69% of people brought a mobile device with them to their last museum visit. People have already been accustomed to holding up their smartphone and other mobile devices to take pictures. Thus, scanning an AR object with the device can easily fit into the museum experience. AR apps have benefited both the museums and its visitors for the three main reasons:

A Stage for Endless Layers of Information
AR tools offer visitors the possibility to deploy their own smartphones as pocket-sized screens through which surrounding spaces become a stage for endless extra layers of information. In addition, comparing with the widely used QR codes scanning mobile feature, which usually is a manual tracking system, the AR feature on museum apps work with automated image recognition to realize the scanning of real world objects.

A Powerful Tool of Engagement
By offering location-based AR apps, museums enable visitors to explore information about the displayed artworks by themselves, and enjoy the live camera view when inspecting the details of a work. Visitors do not only gain some basic knowledge of the displayed artworks or the exhibition itself by checking the labels and texts on the gallery walls, but also absorb layers of information on top of the work. When more information is provided lucidly, conversations among visitors is sparked more easily, and there is a strengthened connection between the museum and its visitors.

Creative Tool of Education
In addition, AR apps allow visitors to obtain knowledge of the displayed artworks through an engaging and informative way. It also inspires the visitors to discover the details of the displayed

works and think beyond the works themselves. Meanwhile, AR can deliver a surprising outcome of kinesthetic learning. According to the findings by the Samsung Digital Discovery Centre at the British Museum, United Kingdom, young children might have trouble holding the phone or tablet steady with one hand while tapping the screen with the other to scan the displayed work. However, after seeing the interaction modeled by adults, children will also easily master the scanning process. They will enjoy a sense of accomplishment when they succeed, and their imaginations and curiosities may expand when using the live camera view.

AR Apps in U.S. Museums

Art Museums

For art museums, an AR app is a wonderful tool that can add interpretive content to the displayed artwork. It also invites visitors to step inside the artworks by themselves. Several art museums have been utilized free AR apps developed by technology companies in their temporary exhibitions. For instance, in 2016, the Seattle Art Museum used the Layar AR app in the exhibition "Kehinde Wiley: A New Republic". There are also art museums teaming up with technology companies to develop software for their own AR apps. The partnership between San Diego Museum of Art and the local start-up Guru is a recent example.

Case Study: ArtLens 2.0, Cleveland Museum of Art

Figure 1. ArtLens 2.0 is an AR app that uses image-recognition software to recognize a selection of two-dimensional pieces of art and aims to honor the museum's visitor preferences according to their interests. It was also designed to model and spark conversations among visitors as they respond to works of art in gallery spaces. Source: The Cleveland Museum of Art.

One of the most well-known AR apps that has been designed and developed by art museums is the ArtLens 2.0 by Cleveland Museum of Art. ArtLens 2.0 is an enhanced version of ArtLens that came out three years ago. ArtLens 2.0 was launched in summer 2016 after a six-month testing and implementing period. The app is both available on Android and iOS.

To put it simply, ArtLens 2.0 is an AR app that uses image-recognition software to recognize a selection of two-dimensional pieces of art and aims to honor the museum's visitor preferences according to their interests. It was also designed to model and spark conversations among visitors as they respond to works of art in gallery spaces.

Besides AR, the app contained mapping and beacon technology, enabling visitors to discover and create new pathways through the museum's collections. The integration of various technologies has made the museum visit experience more engaging and entertaining. The Navizon service, a company that provides indoor mapping technology, gives alerts to visitors when featured artwork on ArtLens 2.0 is nearby. Visitors can then scan the featured art to deepen their understanding and interpretation.

ArtLens 2.0 contains all the features provided in the original ArtLens app, and it is much easier to download. Comparing to the original ArtLens app, which took 5 to 10 minutes to download, the new Art Lens 2.0 less than a minute. It also takes up the same amount of memory. Moreover, instead of using RFID, the app is now taking advantage of Bluetooth technology for the Collection Wall, a 40-foot interactive, multitouch, MicroTile wall that displays in real time all works of art from the permanent collection currently on view in the galleries at the Cleveland Museum of Art.

> **❝**ArtLens is different than almost every other museum app available today because it is a dynamic catalogue of every artwork on display in the museum: providing its name, date, medium, tombstone information, didactics, videos and gallery location, while being updated in real time so it is always accurate. If something is accessioned, moved, put on loan, etc., it will be updated in ArtLens. This is only possible because of the museum-wide backend integration. ArtLens also aims to be the first way-finding option for museum visitors, rather than traditional paper maps."
>
> *- Jane Alexander, Chief Information Officer at the Cleveland Museum of Art*

Since January 2013, the ArtLens app has been downloaded over 70,000 times on iOS and over 9,000 times on Android (which came out at the end of 2014). The remarkable success of ArtLens app is due to two main reasons:

- **Developers actively collect feedback and adjust components of the app accordingly**

The ArtLens 2.0 app is designed to better cater to the museum visitors' needs. Meanwhile, the audience research team at the Cleveland Museum of Art has observed its functionality real-time and conducted interviews with visitors to obtain feedback. In addition, during the app's testing period, museum staff collected on-site feedback and gave it to developers, who still continuously adjust and update features.

- **A museum-wide backend integration**

The Cleveland Museum of Art has made it a point to integrate arts, audience engagement and technologies such as AR and Beacon technology. The museum has been experimenting with creative ideas by integrating and implementing emerging technologies, and also set up a mature system to test, implement, and examine the impacts of all new applications. The institutional integration has assured the museum's communication efficiency and led to the ultimate success of a variety of museum technology applications.

Natural History Museums

Although art museums have traditionally been at the forefront of mobile offerings, natural history and science & technology museums are also using new mobile technology to attract and engage visitors. AR apps provide great opportunities for these types of museums to bring still works to life and ignite visitors' imaginations.

Case Study: Smithsonian Museum of Natural History

Figure 2. The "Skins & Bones" app designed by the Smithsonian's National Museum of Natural History serves as a great example of using AR app for museum engagement and as an educational tool. Source: The Smithsonian National Museum of Natural History.

The "Skins & Bones" app designed by the Smithsonian's National Museum of Natural History serves as a great example of using AR app for museum engagement and as an educational tool.

Released in January 2015, the app was developed for an exhibition called "Bone Hall", which was installed in the 1960s and had virtually no upgrades in the following 50 years. The app aims to share untold stories behind the museum's most iconic collections.

By holding up the phone's camera and simply scanning the featured specimens, visitors can see the skeletons of specimens come into life.

The app was made possible with a grant from Booz Allen Hamilton and is free to download on iOS. The 3D modeling work of featured specimens took place at the museum, and the animations were developed and supported by Virginia Polytechnic Institute and State University.

> **"**The purpose for developing Skin & Bones was to make the exhibit more accessible to visitors, make it more enjoyable and memorable, unlock some of the rich stories these skeletons can tell and consequently increase dwell time, which was 1:34 min. You might say the app repairs the visitor experience."
>
> - Robert Costello, Outreach Program Manager at the Smithsonian's National Museum of Natural History

The percentage of visitors downloading the app is very small due to various reasons. For instance, free WIFI is not available throughout the entire building. Many visitors to the museum failed to recognize that there was free wifi in the "Bone Hall" and so did not think to download the app. In addition, there is little promotion of the app both inside and outside of the museum. Meanwhile, because of the app's size, visitors may find there is a lack of device memory when attempting to use the app.

Figure 3. The "Skins & Bones" app aims to share untold stories behind the museum's most iconic collections. By holding up the phone's camera and simply scanning the featured specimens, visitors can see the skeletons of specimens come into life. Source: The Smithsonian National Museum of Natural History.

It is not easy to gain visitors' attention at the "Bone Hall" and let them explore the exhibition with assistance from the app. However, the museum has received in-depth feedback from those who did use it. User responses are overwhelmingly positive, and the visitors' average dwell time at the "Bone Hall" increased from 1:34 min to 14:00 min, or over a 1,000% increase.

AR apps in University Museums

University museums may have an easy road to increasing the use of AR technology in their gallery spaces. One major reason is that a large group of university museum visitors are college students, who are most likely to already have experience and are more prone to using new technologies. Additionally, university museums can utilize on-campus resources to better identify emerging technologies, and can even partner or collaborate with technology companies or research labs to develop their own AR app. For instance, through partnering with Sid Lee, Stanford University launched an AR mobile application for The Anderson Collection in 2014 in order to provide its museum visitors with a new, immersive art experience.

However, due to a variety of reasons, a lot of university museums may not be able to afford to develop an AR app for gallery spaces. For this reason, utilizing free AR apps developed by technology companies is a good choice.

Case Study: "Layar" App, Blanton Museum of Art

Figure 4. From December 2015 to April 2016, the Blanton Museum of Art used the Layar AR app to provide interpretive information to visitors for its exhibition "The Crusader Bible: A Gothic Masterpiece. Source: Blanton Museum of Art.

The Blanton Museum of Art at University of Texas in Austin is a university museum that places priority on implementing new technologies. From December 2015 to April 2016, the Blanton Museum of Art used the Layar AR app to provide interpretive information to visitors for its exhibition "The Crusader Bible: A Gothic Masterpiece."

Since Layar is an existing app available on both iOS and Android, the museum only ran tests for roughly two hours before implementation. The museum felt it was necessary to tell stories of the artwork in an informative and engaging way, since each plate displayed in the show had descriptions in three different languages – Persian, Judeo-Persian, and Latin, and it would be hard for English-speaking visitors to gain deep understanding of the art by simply looking at the labels. The Layar free AR app provided a great platform for museum visitors to view English-language translations of the three narratives on the museum-provided iPads.

> **"**The app definitely added an additional layer of interpretation that would have been almost impossible to deliver via traditional labels. Given the subject matter of the exhibition, visitors were more eager than usual to engage with the narrative of the works themselves, and the app enabled them to do that."
>
> *- Koven Smith, Director of Digital Adaptation, Blanton Museum of Art*

They found that about 20% of the 9,800 museum visitors used the Layar app during the exhibition. Additionally, they determined the average time spent on the Layar app through the dedicated iPads was around 2 1/2 minutes.

CONCLUSION

For all types of museums that are thinking about using AR apps in their gallery spaces, the following should be taken into consideration:

• **Museum's ability:** A museum should first consider their financial situation when deciding whether to develop their own AR app or use an existing one. A museum should also consider if the app requires free WiFi access throughout the exhibition space.

• **Museum visitors' needs:** The museum should collect information of visitor behaviors and visitor preferences to pre-examine the most effective way to implement AR technology.

• **Special requirements for the exhibition:** A museum should consider the necessity of using an AR app for its permanent collections or a temporary exhibition. Artwork that requires curatorial and interpretive information, other than the text panels and labels, might be best to feature in an AR app.

Museums that have already embarked on using AR apps in gallery spaces should consider the following:

• **An effective evaluation process:** A museum should collect data and feedback for their AR app use, and adjust or update various components accordingly. The feedback from visitors can also indicate areas for improvement.

• **Create awareness among patrons:** A museum should establish and maintain an effective operation and communication system that supports AR app use. In addition, promotion of the AR app both inside and outside the museum is important to attract new app users.

Effective use of AR apps in gallery spaces can help museums achieve various goals and drive institutional changes. AR apps are not just tools for informational and engagement – they are also educational platforms that encourage observations, spark conversation and ignite imaginations. Besides adding additional interpretation for museum

collections, AR apps may also bring surprising value to museums' educational programming. Finally, they may even add value to children's museums and encourage kinesthetic learning.

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1). What factors led up to the museum's decision of developing the "ArtLens 2.0" app? How long did you run tests for before launching?

Gallery One and ArtLens were designed to honor visitor behavior: pre-launch audience evaluation showed that CMA visitors preferred to browse according to their interests. ArtLens uses Beacon technology to follow visitors throughout the museum as they explore however they want, while also being able to search, favorite artworks, and create personalized tours in the app. The original ArtLens app already had most of the features of ArtLens 2.0, including wayfinding, Augmented Reality, and curated and self-made tours --but it was not easy for visitors to download.

ArtLens was upgraded to ArtLens 2.0 in Summer 2016 as a response to user feedback. The new ArtLens 2.0 app can still be downloaded on all Apple and Android devices on or off-site, however, it downloads in less than a minute versus the 5-10 minutes it could take before, and it now takes up as much memory as snapchat. ArtLens also now takes advantage of Bluetooth technology to connect to the Collection Wall, rather than RFID.

ArtLens testing is an iterative process in that the CMA team used test-flight to test multiple components. After we tested it, on-site feedback would be given to the developers and then a new version to test would be available. Early versions of ArtLens 2.0 were available without all the components immediately available. We did this over a 6 month testing and implementing period.

2). Speaking of data, how many museum visitors take advantage of the "ArtLens 2.0" app on a weekly/ monthly basis? What kinds of feedback have you received from visitors about the use of "ArtLens 2.0" app?

Original ArtLens app (NOT 2.0): 9, 508 users tracked between April 1, 2013 and January 29, 2014.

Since January 2013, visitors have downloaded the iOS version 69,792 times and the Android version (which came out in end of 2014) 9,000 times. We had less downloads in 2015 due to the size of the application, which had trouble fitting on many visitor's devices (now fixed).

The ArtLens 2.0 app was rolled out in Summer 2016 so we don't have a lot of feedback or analytics yet, but we just received a grant to do a thorough evaluation of Gallery One.

3). How is the "ArtLens 2.0" app driving institutional change?

ArtLens and Gallery One were the testbed for the museum-wide digital strategy that led to the integration of everything in our backend. ArtLens is different than almost every other museum app available today because it is a dynamic catalogue of every artwork on display in the museum: providing its name, date, medium, tombstone information, didactics, videos and gallery location, while being updated in real time so it is always accurate. If something is accessioned, moved, put on loan, etc., it will be updated in ArtLens. This is only possible because of the museum-wide backend integration. ArtLens also aims to be the first way-finding option for museum visitors, rather than traditional paper maps.

4). Cleveland Museum of Art has been experimenting something incredible that sits at the fascinating intersection of art, audience engagement, and emerging technologies including Beacons technology and Augmented Reality. What has been the most rewarding part of this whole process?

For me, it is especially rewarding to go to Studio Play and see families of all ages playing together, hear from people in person or via e-mail that they and their families love the space, and watch people find the artwork in the museum that they explored in the interactives. The goal of Gallery One is to bring non-traditional visitors into the museum, attract new audiences, give them the toolsets to look closer at the art and keep them engaged

to come back again and again, which we have succeeded in doing. It is also exciting to be part of a museum of this stature that is taking a calculated risk to look at things totally differently than their peers. We are continuing to upgrade Gallery One and ArtLens to remove barriers between visitors and the art, while providing engaging and innovative experiences.

If you have not been able to visit us, these are videos of Gallery One and Studio Play:

- Gallery One: https://www.youtube.com/watch?v=qWJqd6lyJ-E

- Studio Play: https://www.youtube.com/watch?v=xh7KIRO4cHg

Appendix 2: Interview with Robert Costello, Outreach program manager, Smithsonian's National Museum of Natural History

1). What factors led up to the museum's decision of developing the "Skins & Bones" app? How long did you run tests for before launching?

Skin & Bones was developed for an exhibition we call the 'Bone Hall', which was installed in the 1960s with virtually no upgrades to the exhibit in the following 50 years. The exhibit displays skeletons almost as a static parade of 300 vertebrate groups from fishes, to amphibians and reptiles, then birds and mammals. Within the major groups skeletons are arranged into subgroups united by the shared evolutionary history of the members. Case labels generally describe the unique skeletal features uniting the members of the groups and these were written by scientists before the museum had an exhibit office. There is a case on goatsucker birds with a label that reads, "They are either schizognathous or desmognathous and most have basipterygoid processes." So for the past 50 years almost none of the visitors to the exhibit have been able to grasp the scientific concepts underpinning the design of the exhibit. The purpose for developing Skin & Bones was to make the exhibit more accessible to visitors, make it more enjoyable and memorable, unlock some of the rich stories these skeletons can tell and consequently increase dwell time, which was 1:34 min. You might say the app repairs the visitor experience.

We tested the app with visitors to the hall throughout a period of formative evaluation. We tested first versus third person voices, subject headings, navigation; we tracked and observed and timed visitors and recorded their behaviors and conducted interviews, all of which led to adjusting the design. Production spanned two years due to contractual challenges and content development took place over one year.

2). Speaking of data, how many museum visitors (and how much percentage of museum visitors) take advantage of the "Skins & Bones" app on a weekly/monthly basis? What kinds of feedback have you received from visitors about the use of "Skins & Bones" app?

The percentage of museum visitors downloading the app is very small for many reasons. There have been 20,000 downloads since 2015. First, the museum does not have free WiFi throughout the building and when visitors enter the museum and check their mobile devices they do not see WiFi available. Who would expect to find it in the oldest exhibit in the museum? Second, there is very little promotion of the app, such as any small sign at the information desks. Third, the exhibit is used as a passageway by most visitors; only 66% stop at one of the many cases at least once. Getting visitors to notice a small sign, stop, check their devices to locate WiFi and download an app for one exhibit only is unrealistic for most visitors. The usual issues with apps adds to the resistance, such as a lack of device memory, or not upgrading the operating system, of having a limited data plan (for those not noticing the free WiFi).

We have in-depth feedback from visitors using the app. We actually created two version to isolate augmented reality as a variable influencing the visitor experience for research purposes. Diana Marques, a doctoral student from the University of Porto has completed extensive research on the visitor experience for the app. User responses are overwhelmingly enthusiastic and dwell time increased to 14:00 min., or more than a 1,000 % increase. A few of the hundreds of user responses more than hint at their experiences.

". . . the visuals make it more real as opposed to skeletons which disassociate you from nature and reality."

"You could see . . . how the anatomy works . . . being able to take on of these skeletons and visualize how it works when the animal is alive is neat."

". . . it's easy to blow through this exhibition and be 'it's a lot of bones, it's a lot of bones.' Exhibition after exhibition of bones. You lose your interest you could say. But if you could stop it . . . tie it back to information, to make you stop and realize what it is you're looking at."

"As you're moving through, you're like skeleton . . . skeleton . . . another skeleton . . . whereas if you have this thing you can look at it more closely and see how it actually works that keeps it more interesting, makes the exhibit better.

"We just went through the gemstones. And with that it was just sort of "oh that's cool. Oh that's nice. Oh isn't that pretty?" Whereas with this it's "Oh that's cool, oh that's interesting," there's more learning going on than just the visual, taking it on the surface level."

"The scientist talked about how she traveled her whole life, and she was now 70, and we're in our 60s so that was like, "she's 70 and still doing this crazy stuff?!" That was interesting to me, it humanized, not only the exhibition but it humanized the people who were in the exhibition.

3). What data have you used from the app itself to adapt for better UX?

Wayfinding data is very important to the UX, how users find their way through the exhibit and locate one of the featured skeletons. We designed, tested, and retested different versions to understand how people navigate the space and what cues they use. We used map versions with different textual references to orient users, with number references, with icons on the cases, etc., and we tracked, observed and timed users in trials. As a small example, when we observed users were passing by the largest skeleton included in the app because it was mounted above a case, we added "Look up" to that location on the map. Little aids like that. The image is an early prototype of the map interface.

4). How is the "Skins & Bones" app driving institutional change?

I don't agree that this would should be an expectation for an app dedicated to an antiquated exhibit. As the app was developed to provide visitors with an alternate experience, the juxtaposition does create a contrast between the classic object with label exhibit, versus playfully manipulating peoples' senses and experience preferences and using the information to deliver an experience rather than having the information be the experience. In this sense, exhibit developers and educators within the museum can reflect on these different experiences and their own practices.

Also, early testing included prototyping in paper with sample specimens and corresponding content screens. Test participants made selections on the paper menus and with their feedback menu titles were adjusted along with other changes in the positioning of elements and other tweaking to aid usability.

Appendix 3: Interview with Koven Smith, Director of Digital Adaptation, Blanton Museum of Art

1). What factors led up to the museum's decision to use the Layar AR app in the exhibition? How long did you run tests for before launching?

The concept of this particular show was a natural for this kind of AR. We used it in exhibition of plates from the Crusader Bible, on loan from the Morgan Library. The Crusader Bible was owned by several people throughout its history, and each owner left narrative descriptions of the images in his native language. Each plate therefore had descriptions in Persian, Judeo-Persian, and Latin. Layar enabled visitors to view English-language translations of all three narratives on dedicated iPads, which helped them to understand the subtle, but important, differences in the three narrative translations.

We ran tests on printed reproductions of the plates throughout production (which took about a month), and then ran roughly two hours of testing on the real plates once they were installed in our galleries.

2). Speaking of data, how many visitors to the exhibition took advantage of the Layar app?

We don't have true numbers here, as we were using the non-Pro version of Layar, which unfortunately does not provide statistics. Observation showed that roughly 20% of visitors to the exhibition used the iPads, which is about 9,800 people.

3). What kinds of feedback did you receive from visitors about the use of Layar app?

Feedback was generally positive, though many visitors seemed somewhat unsure of the purpose of the iPads and bypassed them entirely (our signage did not do a great job of explaining to visitors how to use the iPads). Once visitors "crossed the threshold" and actually used the iPads, though, the average use was around 2 1/2 minutes (which is a pretty long time) and the feedback was almost universally positive. Uptake was generally higher when the gallery was most crowded, as other visitors would see the iPads in use and wait around to use them.

4). What kind of benefits do you feel the museum received due to including the app in the exhibition?

The app definitely added an additional layer of interpretation that would have been almost impossible to deliver via traditional labels. Given the subject matter of the exhibition, visitors were more eager than usual to engage with the narrative of the works themselves, and the app enabled them to do that. While I am generally skeptical that having tech in an exhibition is in some way a draw to visitors on its own, there was a clear PR value in juxtaposing this kind of tech with the medieval manuscripts that several visitors commented on.

Appendix 4: Free AR apps Museums Can Use

AR App	Features/Advantages	Examples
Aurasma	• Available for both Android and iOS (Apple) operating systems. • Aurasma's website provides plenty of support and guidance on how to make best use of the app. • Users can upload trigger images of their choice and add videos to make their very own augmented reality experience.	• Laguna Beach Art Museum in California made use of Aurasma app • New Bedford Whaling Museum made use of Aurasma app • The Columbus Museum made use of Aurasma app
Layar	• Available for both Android and iOS (Apple) operating systems. • The first AR app to create a platform for businesses to sell their content. • Includes a refined Geo Layer interface that allows the user to find points of interest within a physical location.	• Museum of Modern Art (MoMA) made use of Layar app • Seattle Art Museum and made use of Layar app • Blanton Museum of Art made use of Layar
Gamar	• Available for both Android and iOS (Apple) operating systems. • Has interactive experiences and supplemental information that can be paired with certain locations to enhance museum visits. • Allows museums or art galleries to create educational games and interactive audio tours by themselves.	• The British Museum made use of Gamar app • Gamar partnered with The National Museum of Computing • Gamar partnered with the National Maritime Museum
Blippar	• Available for both Android and iOS (Apple) operating systems. • Very education-oriented: Blippar for Education platform includes a suite of three products tailored for teachers: an Educator Dashboard, an Educator Community, and a special Educator version of BlippBuilder.	• Blippar partnered with Art Everywhere, the world's largest art exhibition: which will see 57 of the British public's favorite pieces of British art put up on 22,000 billboard and poster sites across the United Kingdom. • Blippar partnered with Natural History Museum of Los Angeles County. • Blippar partnered with The Wende Museum.