

NFC AIDED USER CURATION AND NARRATIVE FOR EXHIBITS

By

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B.Sc., University of Waterloo, 2013

This Major Research Project
Presented to Ryerson University

In partial fulfillment of the
Requirements for the degree of
Master of Digital Media

In the Yeates School of Graduate Studies
Toronto, Ontario, Canada, 2015

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Author Declaration

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Abstract

The guided museum-going experience has evolved from docent led visits and information booklets to the addition of smart screens that are more informative and engaging. This project looks into an alternative manner of creating a more immersive user experience for museum goers. I examine the use of radio technologies to help users curate their own narrative, whilst also using these objects as a portal beyond the displayed collection. The process, I propose, is best defined in three steps: By using existing technologies to act as better signifiers, we have the opportunity to get more use out of digital kiosks. By 3D printing these smart objects, we are able to customize and make them relatable at a fairly low cost. In addition, by allowing the users to relate to these objects and take them home allows for a better relation to the museum.

Acknowledgements

The last year was made possible thanks to a group of people whose contributions, mentorship and support allowed me to discover the vastness of this field. This major research project would not have been possible without the guidance of Ramona Pringle, whose enthusiasm for this project allowed me to sculpt myself as a professional and as an innovator. Equal parts gratitude goes to Michael Carter and Sonya Taccone, for providing me the opportunities and space, where I could explore without the constraints of failure and resources. Having the chance to walk in anytime and talk about ideas and concerns really allowed me to embrace the program with a full heart. I would like to also thank my family and friends for backing me through this and my other journeys so far, it is your love that allows me to be who I am. I can only hope to return this in some capacity in the future. Lastly, I cannot thank enough the wonderful cohort I had the privilege of spending this time with. Each and every one of you inspired me at one point or another, and for that reason alone, you have my most heartfelt regards. Here is to the future, where ever it is.

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Introduction

Throughout time, the question of representation has mystified humans. One of the places where this emerges is museum exhibits, places designed to showcase the best and most amusing a museum has to offer. With technological advances, museums and public spaces have started using digital tools to provide more than a glassed display, leading to a better overall experience. Still lacking, though, is the museum staff's familiarity with digital media and the possibilities it provides. Museums are made for display, and until very recently, have been designed by architects and public space engineers. With the flurry of modern devices and technologies, the objective of storytelling has taken a higher priority over the traditional aim of optimizing the crowd flow. These new objectives open the doors for many different technologies to establish themselves in the room (exhibit space) and render them useful for the sake of the narrative. The purpose is to create experiences that start from the time you buy your ticket, to the time when you are at home and reminiscing about your recent visit. While the latest shift towards modern museums has led to some changes, designers still fail to use enough signifiers that are ubiquitous in the environment to allow users to differentiate between an interactive display and one that is "traditional". Here, I define a traditional display as a glass box with an artifact inside and an information plaque beside it. This project aimed to change both that and to also empower the visitors with the feeling of being an explorer.

Problem

Modern museums have to compete against a magnitude of other entertainment sources, in order for them to remain profitable and stay a vital part of community, they more than ever need to be desirable for their visitors. Most museums are trying to solve the problem of capturing their visitors' attention, having them engage with their content and lastly leave with the desire to return. This content needs to act as a hook, which leads to a higher return rate for interaction with both physical and digital artifacts. In order to accomplish this, museums have started to develop experiences beyond the cabinet, with notable advances such as smartphone apps, interactive displays in exhibits, and examples such as the smart pen at the Cooper Hewitt Design Museum in New York.

While these additions lead to a more interactive experience, they are not inherently scalable, transferable or economically feasible for large scale deployment. The aim of this project is to look into available technologies and utilize them in a manner that draws audiences, holds their attention in a public space or exhibit, and allows for them to take the narrative home for later interaction. I compare available technologies to ones that are already in use, and introduce a more feasible model for creating customizable smart objects that utilize a museum's digital collection and pull users back to the original attractions.

At the forefront of modern exhibit design technologies is the Cooper Hewitt Design Museum, a branch of the Smithsonian. The museum initiated a massive digitization process last year and have managed to digitize their collection of over 215K objects (Walter, 2015), allowing them to use their smart pen in a very effective manner. After this massive undertaking, the museum noted a high user return rate on their online collection. This unearths the need for a system that allows user to explore the museum, create their own narrative/journey and revisit it

to feed their curiosity. This widely successful process paved the way for more and more museums and libraries to follow suit. This is where my project comes in, because not all institutions have a million dollar budget to ideate, prototype and test smart objects such as the Pen. Using off-the-shelf Near Field Communication (NFC) tags and the feasibility of a 3D printer, most places that house exhibits can empower the modern user and increase return visitors. Although it might look like a huge undertaking initially, this optimized solution comes at the right time where many curatorial staff are trying to digitize their collection. This modern trend allows for a new ecosystem, where the physical museums offer the user a place to explore the collection, and the virtual museum offers a chance for limitless engagement and learning (Clough, 2013).

Besides the race to digitize, museums have been playing with interactive technologies for a while. These have been implemented in various forms in different places. The Royal Ontario Museum uses an app, “Scopify”, to add an additional layer of content over 13 items in the collection (‘ScopifyROM - One App. Many Ways to See’, n.d.). The museum also uses large-scale interactive kiosks that are waiting to be initiated by pressing the screen. Both of these cases of interactivity lack of signifiers that guide the audience to use the machine or app. In cases where the app is used, the process has so many steps that it is more of a hurdle as compared to the proposed immersive experience. In repeated visits to the physical location, the app or the kiosks was rarely in use.

In order to solve this dilemma and create a better experience, I researched and surveyed additional offerings in a museum setting. From this examination period, the Cooper Hewitt most closely resembled the proposed affordances, while the Chabot Space & Science Center at the California Museum uses similar technologies, but offers a different experience.

When creating an exhibit, designers need to take into account the practicalities of user interaction, including the many things that can go wrong. Constant user research and feedback loops are a good way to stay on top of user tests. Embedding technology is not the only way to make exhibits modern, to be relevant and interesting they need more than the “wow” factor. To design an interaction that is positive and fulfilling, it needs to satisfy one or more universal psychological needs such as relatedness, competence, stimulation, meaning, security and autonomy (Hassenzahl et al., 2010).

In my prototype, I tried to mimic one or more of these feelings in one of the three stages. This allowed me to evolve my design process around the user and contribute to a more pleasurable experience. Another inspiration was to have an explorative aspect to the prototype, allowing for discovery and not directing the users through the exhibit. Frank Oppenheimer, founder of the Exploratorium, advises to not force progress, he states that users usually follow a Brownian motion (i.e. Random) when moving through a place. If they cannot progress forward because of a bottleneck, they will not be as curious to explore or map their own journey. As in the end, the journey is important if not more so than the goal (Oppenheimer, 1976).

Overview

As an applied prototype, I have designed a smart object acts as a ticket, a bookmark tool and a portal back to curated digital collection. By using NFC tags embedded in customizable 3D printed objects, I was able to show the flexibility a product like this can have. The cost of the tags ranges from mere cents to a \$1 CAD, purely depending on the quantity bought. On the other end, a 2.5cm cube costs around \$3 ('3D Printing Price Check', 2015) when not printed in bulk. Making it a more affordable solution as compared to the Pen at the Cooper Hewitt. As seen in *Figure 1*, the base of the object is universal so it can house the small NFC tag. On top of the base is a version of the Student Learning Center at Ryerson University; this can be customizable to whatever exhibit this prototype is a part of. Making it a very empowering and relatable experience for the user, not only when they are at the location but also when they go home.....

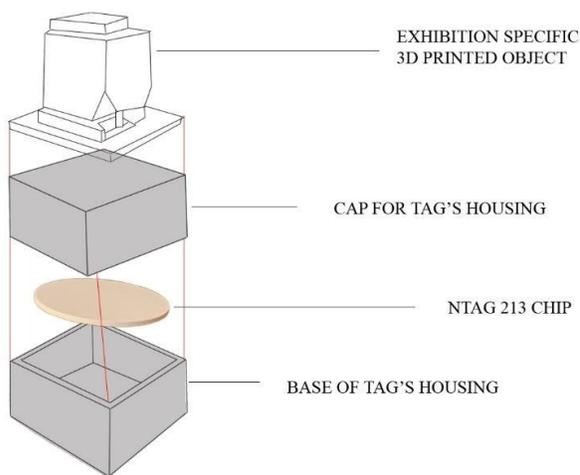


Fig.1 Diagram of Basic Prototype

These tags can act as initiators, while the NFC readers can be attached to the interactive displays or kiosks. I used the ADA Fruit Industries NFC shield for Arduino, to act as a reader and writer for this prototype. This ensured that I was able to program it with my skillset. In an ideal setting, the user gets to pick an object from a few already sampled artifacts. After the user

has selected their artifact, they would be asked to customize/register it for themselves. By completing these two steps, they have already immersed themselves in the exhibit and have made it more relatable to their interests. The registration page can also be used as a tool to

customize interest profiles and act as a bridge for exciting the user. With their object in hand, users can navigate the exhibit according to their own liking, tagging objects they like and storing them onto their online profile. For exhibits with more hands on displays, users get to tap these portals with their tickets. By doing this, they upload their profile to the display, which may include a story, a game or an online sharing platform. At minimum, it displays their name and bookmark the resulting interaction on the online private or public profile. The possibilities here are endless and that is part of its success, as exhibit designers have one less thing to worry about when they are revamping the place or adding to the exhibition. Throughout the exhibit space these smart objects need to have distinct signifiers, such as an interactive map or colored labels, which over time become common knowledge for the users who interact with them. When the users does interact and bookmark their points of interest, they are educating themselves with content they can relate to and are stimulating their brains by actively activating their ticket. Simulation and relatedness in a technology based interaction are known to create positive experiences overall (M. Hassenzahl et al. 2010). Lastly, when the users leave the exhibit, they get to take the object home as a souvenir. The tags are multifunctional in a sense, as that they can be read by most NFC enabled smart devices (i.e. Smart phones and tablets). At the most basic level, these tags can open the online dashboard of the users' trip while also showing them upcoming events they will be interested in. On the higher end of technology, using this with Augmented Reality apps, exhibits can allow the users to have their personally curated collection pop up in their own homes.

Below is a flowchart that summarizes the experience from start to finish.

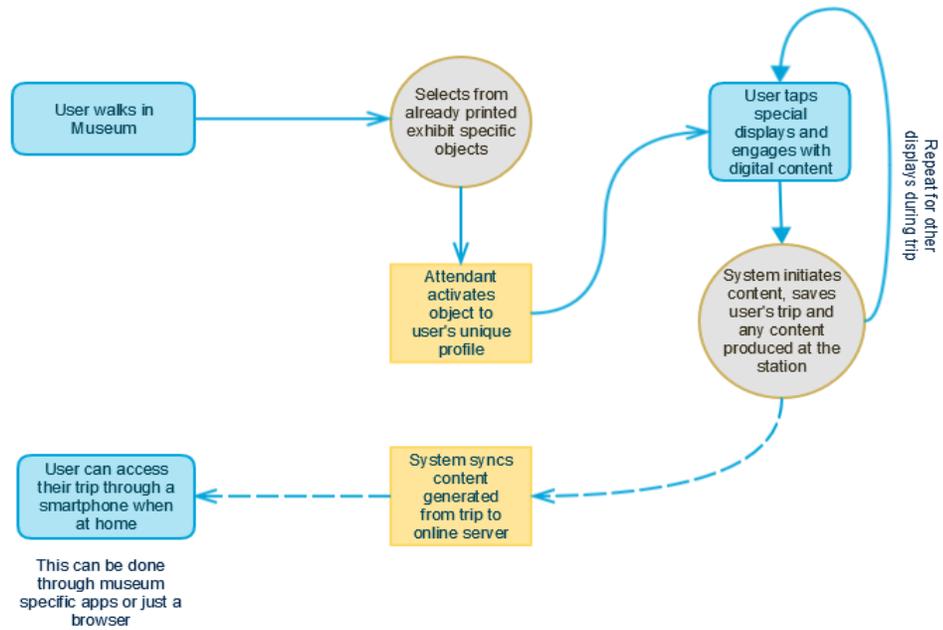


Figure 2. Summary of User Journey

Users

There are both primary and secondary users for this project. The primary users are the visitors to the museum, for those this project is all about the experience it creates. The secondary users are the museums themselves, they act as the back end infrastructure that makes the different components of the project relatable for their visitors. The beauty of this experience lies in the fact that it is useable by everyone. People of all ages can get excited about selecting the design of their own object, while the more advanced users can become their own curator. Due to the simple act of tapping to initiate this, the smart object transcends languages and culture. G. Wayne Clough (2013), the secretary of the Smithsonian Institution says, “Digital technology is pervasive... its use, particularly by the world’s youth, is universal; its possibilities are vast; and everyone in our educational and cultural institutions is trying to figure out what to do with it all.” Making this a perfectly targeted experience for the prized Millennial demographic, a group whose attention needs to be acquired now. In order to this, museums need to not only create an online version of their un-displayed artifacts, but also need to feed the modern youth’s hunger for creating their own experiences (Merritt, 2015). By marketing this and similar projects to Millennials, we can create a buzz around the experience and therefore get more publicity for the institution.

Technical Process

As with many projects, the design process for this project was iterative, and the prototype deviated from the original concept through iterations, user tests and trials. The goal was to have a narrative guide that got rid of the need of asking the audience to even initiate the screens. I was aiming for a ubiquitous eco-system that would work without user initiation. The decision was made to use RFID (Radio Frequency Identification) tags, more specifically Low Frequency tags that work between the 125 and 134.2 kHz range. The advantage of using these was the fact that they can work in many everyday environments, are universally applicable and have a range from a few cm to a couple of meters. (RFID Canada, 2012). These properties made them the perfect solution for me to implement in my project, but the transponders required to read these tags, and the skills needed to program these were both out of my budget and time frame. Naturally, the next step was to move on to a different tier of tags, this is where the MiFare Classic 1K NFC tags come in. These are considered High Frequency tags and have multiple advantages over the low frequency tags, especially in the case of the proof of concept I was building. In summary some of the advantages included being of a lower cost, faster communication speed and the ability to read multiple tags simultaneously. The biggest loss in this case was the range, as these tags work well between 0.75m and less (RFID Canada, 2012). High Frequency tags are also the principal technology behind NFC and were the reason behind the switch from creating a passive system to one that uses a slight tap to initiate applications. The reader or transponder in this case is the ADA Fruit PN532 shield for Arduino, it's an add-on to the Arduino open source environment and came with the required perquisites to allow me to experiment with the different materials and distances. The primary research showed positive results for both being able to communicate through the plastic polymer, used most commonly in 3D printing, to working properly in case of

multiple tags present in the same vicinity. An interesting problem that arose was the ability to use the MiFare Classic 1K cards with modern cell phones. While this was not a concern early on, the more I wanted to use these as a portal between the museum and visitors, the more I realized the potential of them failing in a bigger context. After digging deeper into this (add the NFC guide book reference), I learned that after the introduction of Google Nexus 4, the processor used by most modern devices had been upgraded and therefore does not support the MiFare Classic anymore. To target most smartphones and in-turn a bigger user base, I switched the MiFare Classic tags to Ntag213 tags, as they are universally more compatible (Igoe et al., 2013)

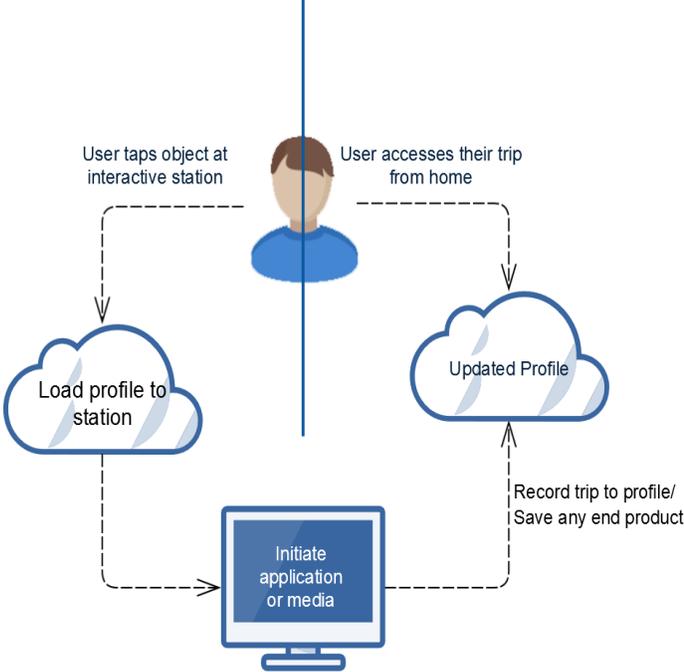


Figure 3. Flowchart of actions after user taps at an interactive display.

The basic code in this proof of concept, authenticates the tag and triggers the relevant media for that tag, exemplifying the possibilities of its use beyond the small scale version accompanying this paper. The media in this case can be anything from a digital journal, to a camera or even an interactive application that is relevant to the exhibit. In order to get a better understanding of the overall process, we can look at *Figure 2*, which earlier represented how the back-end system would work and the actions required by both the user and museum staff at different points on the user's journey through an exhibition. *Figure 3*, focuses solely on the actions that will occur when a user taps their object within the museum premises and at home. _____

In order to ensure the last part of the project was feasible, I used a modern smartphone i.e. the Google Nexus 6 and with the help of the NFC Task Launcher application, able to program the tags to open unique URLs. In order to make it more secure and have a more streamlined experience, I locked these tags so they could not be recoded. This allowed me to show at a very basic level to how the objects will act as a portal to the museum's digital collection and the user generated narrative created while at the physical location. At later stages, this can be linked through the museums native application. Although these tags were programmed using a third party application on a smartphone, this was also possible through the use of the NFC shield for Arduino. When using the Arduino shield the process was faster and less cumbersome, suggesting the use of similar devices in a larger scale.

In the last few years, 3D printing has become a dominant tool in both the prototyping and mass customization industries. With 3D printers becoming increasingly available, many museums have started experimenting with this technology. Among these museums, a special mention goes to the likes of The Art institute of Chicago, The Metropolitan Museum of Modern Art and The Smithsonian. These museums have not only allowed their collections to be available

online, on sites such as Thingiverse, but have also allowed these objects to be remixed, free of cost (Neely & Langer, 2013). Selecting 3D printing as my mode of presenting these objects, allowed me to use the accessibility of this service and combine it with the comparative low production cost to many other industrial methods (Berman, 2012). Most of the design iterations with the 3D object were practical considerations, done to accommodate the tag, without it breaking or it looking out of place in a household setting. Early iterations caused the overall design to feel broken because of the how the tag sat inside the base. Resulting in it either sounding broken, when it was too loose or the base being too thick for easy communication with the NFC reader.

One major change that occurred was the addition of the cap, as seen in *Figure 1*. The cap acts as the base for the 3D printed object. In the first prototype, the object was directly placed on top of the bottom piece, resulting in the tag moving around quite a bit while inside the base and therefore making it sound like it was broken. The “base” centric object design was used mainly to serve as a support for the object when placed on a flat surface. This works in the long the run because the object on the top can take shapes and sizes that might not be stable on their own, especially if they were free standing. Keeping in mind the future possibilities and the ambition of taking this concept to other use cases, the implementation was done by prioritizing the NFC capabilities and not the tag’s shape and size in mind. Overall, the minimal viable product is able to hit off all the checkmarks to make this a working storytelling aid in different settings. In future models, the ability to replace the NFC tags with RFID is a major area that needs to be explored and implemented. On top of that, the use of augmented reality technology to give more life to the objects at home can greatly expand the experience of the visitors.

Use cases

This prototype was designed for museums use and other exhibit spaces. To test how easily this technology is transferable to other environments, I have included additional scenarios in which this can be easily implemented for a more interactive, customizable user experience.

Libraries: Many libraries such as the New York Public Library (NYPL) have huge collections of artifacts that they are willing to share, but have a hard time getting their audience to relate to these artifacts. In order to use these digital collections effectively, while simultaneously make them be a part of a more engaging and memorable experience. Libraries are looking into different ways this can be achieved (Marwit, 2015). A slightly different version of my project can then be utilized in this context. Instead of adding the NFC tags in 3D printed objects, they can be embedded into paper bookmarks, the user's library profile can then be linked to these and they can be assigned a literary character to be their guide. This guide appears when the user taps their bookmark at interactive stations in the library. The digital guide can suggest different books, according to their checkout history, while also tapping into the digital collection to suggest artifacts in the library's collection most relatable to the user profile. This use case is most effective for engaging younger audiences and was presented to a positive reception this summer for an upcoming exhibition at the NYPL's main branch.

Universities: Most institutions presently use NFC enabled student cards to allow access to different sections of the campus, while also using these cards for identification and other administrative purposes. Modern universities also utilize digital kiosks that are touch interfaces for students to interact with and get more information about the building. Combining the student cards and digital kiosks allows us to curate a better, more personal experience for students. As an example, if a student has booked a room to study in or has an appointment with their professor.

They can tap their cards on the kiosk and get step by step directions from the kiosk to their destination. This can be particularly useful for new students, while senior students and staff can use this to educate themselves about any events of interest in the building or around campus. In this use case, the project relies on the card's ability to curate personalized content for each student while also giving them the opportunity to connect with other services on campus that they can find useful.

Retail and Brands: As with the recent trend in non-conventional advertising, retail brands can use different components of the technology to create different interactive experiences for their consumers. Sport brands can utilize digital kiosks around the city and create mini-games to make the physical space become part of a digital playground, e.g. Nike can organize a Toronto wide run, where different participants have to race from one kiosk to another depending on the level of difficulty they select. After tapping their NFC enabled object (customized to the user), they are rewarded or provided clues to head to the next checkpoint. Successfully using their brand power to promote fitness, awareness of the local community and the ability for their consumers to personalize their experiences. This also provides a novel way for these brands to introduce new products and engage consumers beyond what they are used to from these retailers.

Analysis

The inspiration for this research undertaking was with the goal of incorporating new technologies into the museum experiences, to take the collection beyond the museum wall and engage a more educated and connected audience. This concept was iterated and refined continuously throughout the development process, from the time this was a sketch on a journal, to the day it was finally built as a proof of concept. One of the biggest reinforcements came from Stephen E. Weil (2002), who in his book “Making Museums Matter”, suggested providing stimulation and empowerment to the public in environments where information is being provided,

“We approach the museum visit not as an end in itself but as a starting point, rather for a process intended to continue long after the visitor has left the museums premises”.

When one thinks of this as the starting point, we really see the true value this project holds. Due to its affordability, this can be used by museums of all varieties and budgets. Incorporating tags that are compatible with most modern devices, allows the trip to be taken away from the walls of where it started. Giving curators the opportunity to add more to the content than what is available behind the glass display. When users are empowered to create their personalized narrative in an educational setting, especially like that of a museum. We see more interest in not only the museum but also in the content it stores, this was seen to work positively in the re-opening of the Cooper Hewitt Design Museum. After the Pen was introduced 27% of the users accessed their diaries after leaving the museum (Chan & Cope, 2015). Clearly suggesting the need for a device that not only lets users be their own explorers, but also provide an easier way of getting to their curated content. This becomes more valuable, when you realize the overall return rate for content

beyond the museum premises is at a mere 10% (Wechsler, 2014). Two of the key assets of this proposed use of technology are its low cost, as compared to the \$81 Million budget of the Pen, and a much easier portal back to the user content. The Cooper Hewitt itself is struggling with this problem, having seen a drop from their highest return-rate of users accessing their diary at 35% to 27%, this fluctuation is thought to be related to the difficulty of the URL and the tickets design with a complicated call-to-action (Chan, 2015). Using a simple tap action from a NFC enabled smartphone, effectively deals with this problem and promises a higher return rate from users leaving the museum premise. Museums aiming to use this as an educational tool have the ability to enhance serendipity, the idea of the user discovering something new. When a user discovers something new they are more likely to reinforce it in their heads and have a more valuable experience in general. As serendipity is regarded as one of the most vital experiences in a museum like setting (Howes, 2007). In order for this to work effectively, we also need to ensure the overall experience of attending an exhibit embedded with this technology is positive. Museum goers learn when they have their practical needs met (Hein, 1998), which means that before this technology is embedded at any scale, it has to be rigorously tested in regards to its environment and intended audiences. A lack of this step can render this experience useless and therefore lead to disappointment, generating the complete opposite of what was initially intended.

All museums have areas that stand out more to the public than others, these areas and exhibits over time become the major attraction. This allows the museum staff to create memory maps of the exhibit space and crowd flow. A vital tool for institutions big and small (Catlin-Legutko & Klingler, 2012). Traditional museums require staff to track this information. By collecting data from tag activity, the museum can get a better understanding of where these

hotspots are. Not only that, they can use this to see which artifacts or themes are more popular and use this information to guide future exhibits. This is especially useful for museums that are smaller and thus don't have the same amount of resources as their bigger counterparts. Since these objects are passive and the readers are placed inside the kiosks or displays, the experience doesn't rely on visitors using their personal devices, at least while in the museum's premises. This might not be an issue in some circumstances, but has been a cause for concern in the overall trend of using user smartphones as media portals. The user's perception of how affordable they are with their battery usage and network plan regulates how much they engage with interactive exhibits, especially those that require them to use their personal devices (Din & Hecht, 2007). Museums such as the MET and MOMA have started dealing with this by providing free WI-FI, charging stations and even renting iPhones for their ticket holders. This problem practically erases itself with the use of the NFC tags, while also creating a higher probability of users to interact with the exhibits without the concern for battery life and cellular charges. A special emphasis also needs to be given to the ability for this experience to empower users and how it helps the museum in the long run. Novel uses of new and old technologies act as a horizon for many new applications, users are given new opportunities for content aggregation and personalization (Din & Hecht, 2007). Through creating personalized profiles that update according to the user's interest and interaction activity, the experience allows for unique journeys. Over time, users who visit more than others can be given special offers or sneak peaks into what goes on behind the scenes. This creates an opportunity for the museum to get a better understand the visitors and adapt to their needs accordingly. Museums move in their purpose in revolutions, initially about 200 years ago, they served to raise the level of public understanding and that of superiority. That has changed over the last 40 years or so and they now act as a

service to the community and serve the community in order to foster imagination, promote discovery and memories through object-based experiences (Weil & Pachter, 2002). One can suggest that this revolution is a reason for the acceptance of technology and the priority for personalized user journeys. The combination of the evolving purpose of a museum and the digitization race happening all over, makes this project very timely.

As we saw through the different use cases and the simplicity of setting up the technology for various environments, NFC enabled objects can easily be used for a variety of purposes and that is the reason behind their success and development overall. Seeing as how timely this is, while also looking at the value experiences created by this hold, the need for such technologies cements their place in the market. Going forward, the aim for this would be making it streamlined and executable in a manner that is effective in any environment. Emphasis needs to be added to the different applications that can utilize the NFC tags successfully, while allowing users to curate their content. Lastly, taking this product from the proof of concept stage and executing it would require a more technical team that can create the applications for both the museum premises and the interface for the portal from the visitor's home. If successfully executed this project can change the way we look at our trip to the museum and can inspire a generation of new explorers while feeding the curiosity of the others.

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