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One Space, Many Audiences

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Museums Victoria

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An Interactive Qualifying Project submitted to the Faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the degree of Bachelor of Science

December 12, 2018
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WORCESTER POLYTECHNIC INSTITUTE
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by
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Date:
12 December 2018

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This report represents work of WPI undergraduate students submitted to the faculty as evidence of a degree requirement. WPI routinely publishes these reports on its web site without editorial or peer review. For more information about the projects program at WPI, see http://www.wpi.edu/Academics/Projects.
Executive Summary

Beyond Perception: Seeing the Unseen is the newest permanent exhibition which opened in 2018 at Scienceworks, the local science museum in Melbourne, Australia. Beyond Perception is Scienceworks’ answer to the need to ignite Science, Technology, Engineering, and Mathematics (STEM) interest in Australian teenagers; the exhibit was designed specifically for visitors aged 14-17. After opening the exhibition, the museum noticed that visitors of all ages were enjoying Beyond Perception even though they were not in the target audience. The museum is seeking recommendations to help Beyond Perception best serve as broad an audience as possible. To help Scienceworks tailor Beyond Perception to cater to as many audiences as possible, we completed the following objectives:

1. Consulted with exhibition curators and museology research
2. Created a database of visitor feedback about Beyond Perception
3. Evaluated the engagement and impact of Beyond Perception on visitors
4. Developed recommendations to help Beyond Perception serve a broad audience

To prepare for our study, we researched exhibition evaluation methods at other museums. We took a guided tour of Beyond Perception with Jonathan Shearer, General Manager of Scienceworks, to gain insights on the intended impact of the space to keep in mind during our work. The major portion of our visitor analysis was a visitor tracking and timing study. We randomly selected 61 visitors to track their path on a map while we recorded the amount of time they spent at individual attractions within Beyond Perception. The data obtained from this study was used to measure holding power, attracting power, and visitation rates for the different parts of Beyond Perception.

We used visual observation of visitors to measure engagement and
shape our recommendations for Beyond Perception. We complemented tracking with observations because the amount of time a visitor spends near a particular attraction is not directly correlated with engagement. For example, someone could spend an hour reading and interacting with the exhibit, or an hour talking on the phone in the exhibit. For each of the 61 visitors that we tracked with pen and paper methods, we recorded observations of their behavior on a visitor tracking matrix (Appendix cross reference). We recorded facial expressions, social patterns, and body language.

We also tested the viability of Bluetooth tracking, as it was developed by Eduardo Oliveira in his McCoy Research Project with the Melbourne Museum “Understanding Reflective Learning Experiences in Museums”. Oliveira made Bluetooth beacons, android phones, and his tracking application available to us. The beacons were specifically placed to coordinate with major attractions in the exhibit. The beacons connected to the android phones, which would record the closest beacon at 300 millisecond intervals. The data was stored in a .txt file on the phones, which then had to be put through a parser to analyze. We analyzed the Bluetooth data for insights on Beyond Perception visitors but also to compare the technological method to the traditional visitor tracking method.

We wanted to use visitors’ thoughts and opinions to guide our recommendations for Beyond Perception. We surveyed visitors about their thoughts on Beyond Perception’s educational impact, age appropriateness, and preferences within the exhibition. The 30 surveys were analyzed to find trends in visitor feedback on Beyond Perception.

Cosmic Events is an attraction about how black holes create gravitational waves. An analysis of our data revealed that it had a strong attracting power, but low holding power. We often saw visitors pass by without touching the interactive mesh screens of black holes. We observed
only a small fraction of visitors actually stop and watch videos or read the script on the wall.

Wrapped in Spectrum is a series of screens that run parallel to the entrances of Beyond Perception and display different kinds of wavelengths. Our visitor tracking and timing data revealed that Wrapped in Spectrum had one of the lowest attracting and holding powers in Beyond Perception. Our observations noted that visitors of all ages would try to touch the screens; when a visitor discovered the screens were not interactive, they would quickly move on to another part of Beyond Perception.

The Turrets are two portions of Beyond Perception that can be found at either end, and display wind maps and filtered cameras for visitors to interact with. Our tracking and timing study uncovered that a very small minority visited either turret. However, the visitors who did discover the turrets would interact with the map or camera.

Energetic Vibrations is a section of Beyond Perception that informs visitors about the importance of vibrations in the creation of sound. The attraction features vibrating couches that are synchronized to projections on the wall. The attraction had low attracting power but high holding power. Often times, visitors would walk by the couches without realizing that they were an interactive feature. Those who did sit on the couches would often stay there for long periods of time and enjoy.

Waves at Work teaches visitors about microscopes by featuring 8 floor length mirrors and large screens with looping videos. Waves at Work had low attracting and low holding power over visitors. Children would often run around and play in the mirrors, while adults would often walk into the attraction in the middle of a video and not stay to watch the entire clip.

To increase visitor engagement, we recommend that Museums Victoria add instructions to the interactive features of Beyond Perception. We recommend adding an indicator that the black holes in Cosmic Events are
interactive, and an indicator that the screens in Wrapped in Spectrum are not interactive. The Turrets would benefit from a sign that indicates their placement to visitors. To increase the attracting power of Energetic Vibrations, we recommend that the museum creates an indicator that the vibrating couches are different than the regular couches featured elsewhere in the exhibit. To improve Waves at Work, we recommend that Museums Victoria removes some of the mirrors and includes seating to invite visitors to sit and watch the looping video clips.
Abstract

Beyond Perception is the newest exhibition at Scienceworks, a branch of Museums Victoria in Melbourne, Australia. It was designed to ignite an interest in Science, Technology, Engineering, and Mathematics in teenagers. We conducted a visitor tracking and timing study, visitor surveys, and observational studies to assess visitor behavior in the exhibit depending on age. We evaluated the holding power and attracting power of the exhibit. We surveyed visitors to determine the educational impact of the exhibit. We tested Bluetooth visitor tracking inside the exhibition and identified its problems with implementation. To increase visitor engagement, we made recommendations for improvement, in particular that Museums Victoria add instructions to the interactive features of Beyond Perception.
Acknowledgements

We respectfully acknowledge the Traditional Owners of this land, the Boon Wurrung, and Woi Wurrung peoples, and honour their Ancestors, Elders and next generations of community. We also acknowledge the First Peoples of Australia and those from other countries who are visiting today.

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1 Introduction

Museums must understand the reactions that a diverse audience has to their exhibits. They risk becoming irrelevant if they do not appeal to diverse audiences (Levitt, 2015). Museum directors evaluate the effectiveness of an exhibit by gauging the reactions from visitors. The effectiveness of an exhibit can be assessed by tracking and timing visitors and by observing verbal and nonverbal reactions. This can be difficult to measure because of the many verbal and nonverbal elements: facial expressions, body language, volume, and time spent in a specific area of the exhibit (Baruch, Spektor-Levy, and Mashal, 2014). Visitor tracking and observation reveal which parts of an exhibit attract the most attention and whether or not the exhibit is impacting audiences as intended. If there was an industry standard procedure for visitor reaction evaluation, then any museum director could gauge the intended impact of one of their exhibits. Without a standard evaluation methodology for visitor reactions, it is necessary for museums to measure their own success and to create their own methods of evaluation. The issue of not having an industry standard procedure was documented by Tröndle et al. (2012), when they investigated the effects of curational arrangements at the St. Gallen Fine Arts Museum in Switzerland. His team was forced to create their own tools and statistical procedure to quantify the effects of various spatial arrangements of the same exhibit (Tröndle et al., 2012). The study in the Swiss museum delineates the struggle museums face when trying to assess how their decisions impact visitor reaction.

In Melbourne, Australia, Museums Victoria recently invested in a kinesthetic science exhibit called Beyond Perception: Seeing the Unseen. The exhibit cost $3.75 million (AUD) to create for the purpose of igniting curiosity in teenagers about Science, Technology, Engineering, and
Mathematics (STEM) (*Scienceworks target teenagers with Beyond Perception*, 2018). A team of scientists and teenagers designed the exhibit to be especially appealing to teenagers. To properly assess the current reach of the exhibit, Museums Victoria requires a way to measure visitor experience. Because of the lack of an industry standard method, Museums Victoria must create an original procedure for measuring visitor reaction. This original procedure must consider ethics on both the societal and professional levels. Our procedure must account for the individual characteristics of Beyond Perception and Museums Victoria. Our project team has drawn on past museology research and similar evaluations at Museums Victoria to develop an evaluation procedure for Beyond Perception. We conceptualized and executed an assessment of Beyond Perception on its visitors. We investigated the relationship between Beyond Perception and different reactions of the Beyond Perception audience, to make recommendations that will help one space serve many audiences.
2 Background

2.1 Function of Museums in Society

2.1.1 Definition of Museum

The function of a museum is to present material of religious, historical, or educational significance to provide the public with education and enjoyment (Arinze, 1999). Museums expose people of all ages to a variety of educational material, allowing the general public to expand their knowledge. Museums create an overlap between knowledge and culture by presenting the public with information, preserving key artifacts, and researching significant world developments. They allow visitors to take control of their own learning and foster an appreciation for the exhibit (Gardener, 1991).

2.1.2 Museums as Educators

Livingstone (2006) classified distinct types of learning and correlated those types with the physical venues where they take place. According to Livingstone, the four main types of learning are: formal, nonformal, informal, and self-directed. Formal learning happens in a classroom: identified by a person of authority, like a teacher, deciding if someone has comprehended enough material. Nonformal learning happens when someone chooses the field they are studying and turns to experts to help them, such as what happens in traditional college classrooms. Informal learning happens when an expert guides someone’s knowledge of a subject, without a predefined curriculum: much like an apprenticeship or internship. Self-directed learning is characterized by someone learning a new subject in the absence of an expert (Livingstone, 2006).

Self-directed learning is the primary method of education in museums. Museum visitors experience exhibits without an expert to explain the
content of the exhibits. The self-directed learning of museums allows someone to understand exhibit content on their own terms. Museums make information accessible to the public to foster their self-directed learning in the area of the exhibit (Livingstone, 2006).

Education is correlated with a high quality of life. Someone who is educated in a variety of topics has the opportunity for greater social, emotional, and intellectual growth (Flanagan, 1982). Museums provide the opportunity for people to direct their own education, allowing them to create their own conclusions about the world. Being educated has great life benefits, therefore going to museums has great life benefits. Museum directors must carefully plan exhibits to allow visitors to discover the information for themselves, being the catalyst of self-directed learning.

Museums need to captivate visitors to facilitate an appreciation for the subject. Exhibit designers conceive attractions that will captivate the public in order to satisfy this need. Additionally, museums must motivate the public to attend by properly advertising exhibits (Csikszentmihaly and Hermanson, 1995). Curators must consider how welcoming an exhibit may be to a visitor. Without considering this, exhibits may be dense with information but lack engaging and palatable content. Curators can create a “barrier” between visitors and the exhibit content, when the needs of the public are not considered (Carliner, 2001).

2.2 Museums Victoria

Museums Victoria is Australia’s largest public museum organization. Established in 1854, Museums Victoria is responsible for three smaller museums: Melbourne Museum, Scienceworks, and the Immigration Museum. In 1992, Scienceworks opened up as a stand-alone museum in Spotswood, dedicated to motivating visitors to interact with all disciplines of science (Scienceworks About Us, 2018). Today, Museums Victoria

2.2.1 Scienceworks

Scienceworks opened in 1992, born out of the idea of seeing young people physically play with science (Scienceworks About Us, 2018). Scienceworks contains immersive exhibits that are designed to challenge the mind. An example is Ground Up: Building Big Ideas, Together (Mannix, 2017). Scienceworks designed the exhibit for 0-5 year olds, with the purpose of exploring STEM in a physical and interactive way (Scienceworks target teenagers with Beyond Perception, 2018). This exhibit is a screen-free exhibit that encourages all children to explore STEM. It contains features such as flight tubes, where children can build contraptions and see how they fly in a wind tunnel, and a wall with hundreds of light switches, with the purpose of encouraging the development of deductive thinking (Ground Up at Scienceworks! 2017).

Scienceworks wants to position itself as the “Museum of the Future,” by engaging audiences with the possibilities of the future (Strategic Plan, 2017). The focus of this project, Beyond Perception: Seeing the Unseen, is also one of Scienceworks’ immersive exhibits (Scienceworks About Us, 2018). Beyond Perception: Seeing the Unseen engages audiences with the possibilities of the future by exposing them to high level science and encouraging them to explore STEM in their lives.

2.2.2 Beyond Perception

Beyond Perception: Seeing the Unseen is the newest permanent exhibit at Scienceworks. The government provided $3.75 million (AUD) in funding for
the exhibit in hopes of getting more teens involved and interested in STEM. Scientists and curators met with a group of local teenagers, known as the JBoard, to design Beyond Perception with an intent to impact teenagers (Scienceworks target teenagers with Beyond Perception, 2018). This exhibit is an immersive, hands-on experience that shows unseeable parts of the world, like gravity and air flow (HOT: Beyond Perception: Seeing the Unseen, Scienceworks, Spotswood, 2018). The exhibit designers wanted a modern topic that could spark interest in teenagers. Designers chose invisible waves as the topic of the exhibit because of the many Australian universities and laboratories researching this topic (Shearer, 2018).

Jonathan Shearer, Acting General Manager of Scienceworks, designed Beyond Perception to function as a social and educational space. Shearer intended for teenagers to congregate in the many areas with seating options, and then to branch out, explore, and interact with the exhibit. After a bit of exploration, the hope was the teenagers would reconvene in the common spaces. The JBoard suggested that Shearer design the interactive parts of the exhibit to have a goal, so teenagers could work together or compete against one another in the exhibit. However, Shearer decided to make the interactives open ended, in hopes that visitors would create their own goals (Shearer, 2018).

Shearer wanted to create a “more personal than fact based experience” (Shearer, 2018). Beyond Perception is a non-linear exhibit with multiple interactives, visuals, videos, and a customized soundtrack. Shearer intended for visitors to manipulate the interactive elements of the exhibit, and then look at the information on the walls of the exhibit to explain what they just did. Shearer prioritized sparking curiosity in visitors for future research and discovery over ensuring that visitors left with “a whole lot of facts.”
2.2.3 Our Project

Beyond Perception was the setting of our project at Scienceworks. We will be examining the impact that Beyond Perception has on its visitors, and what causes it to have these impacts. We will compare the impact of Beyond Perception on specific types of audiences to identify how Beyond Perception serves, or does not serve, different types of audiences. The question we need to answer is: How can one space cater to many audiences?

2.3 Comparative Museum Research

2.3.1 Worcester Art Museum

To prepare for our work at Scienceworks, we reached out to the staff at the Worcester Art Museum (WAM) to learn more about the operations at museums. WAM has been displaying an eclectic collection of works from across time and across the globe since 1889. At WAM, we discussed exhibit design and evaluation with arms and weapons curator Jeffrey Forgeng. Forgeng shared that, like Museums Victoria, WAM had no standard method of exhibit evaluation and relied on anecdotal evidence to decide if an exhibit had the intended impact (Forgeng, 2018). Forgeng and the team at WAM invited us to walk the galleries to begin researching what characteristics make an exhibit successful.

Major exhibit pieces often captured our attention more than dense textual labels. These labels tried to teach visitors about the artwork, but were often overlooked. We also noticed that the labels tended to be black lettering on dark red or blue backgrounds. The lack of contrast between the text and background, in addition to ambient lighting, made the labels difficult to read.

We also took notice of the seating throughout museum, which consisted of separate wooden seats conglomerated into benches with abstract
arrangements and angles. Immediately after entering the gallery, we gathered around the bench and started talking about how unique and original they were. Then, we realized that we were spending longer talking about the bench than the actual artwork. The attention grabbing scenery distracted from the artwork, therefore lowering our engagement with the major exhibit attractions.

The variety of spatial arrangements between exhibits maintained our attention during the visit. Each exhibit was physically presented in a different way, which made every part a new experience. Some exhibits contained multiple pieces of artwork closely placed together, while others displayed artwork far apart. Some spaces used bright lights, while others were dimly light. The visual and spatial diversity between exhibits kept us engaged with each part of the museum.

2.3.2 Boston Museum of Science

The Boston Museum of Science is regarded as one of the most prestigious secondary learning facilities in the world. The comparison can be made to Scienceworks due to their many years of success as a science museum. The Boston Museum of Science provided us with an extensive list of comparable studies that they have worked on. The faculty have thought a lot about the topic of diversity and consider this to be a pressing issue. Last spring, the institution hosted a meeting of museum professionals across the country to discuss the coalescence of exhibition design strategies for different audiences (Todd, 2018).

One specific exhibition example that the Boston Museum of Science focused on was the “Science Behind Pixar” (SBP). This study focused on doing a summative evaluation report for this exhibit and aimed to answer critical questions about the exhibit such as: what did audiences learn from the exhibits, how did audiences feel about their experience at SBP, and how
did different exhibit design features impact the social, physical, and cognitive experience for visitors, especially visitors with disabilities? The Boston Museum of Science recommended this study as a model for ours because of how they examined the impact of SBP on visitors with disabilities. The SBP study utilized visitor tracking to better understand the paths each person took. The first takeaway is that almost all the exhibits that were hands on learning appealed to their target audience of ages 7-12. The second takeaway is that no single exhibit type defined SBP, and no one feature outshines the others (Cahill et al., 2018). Science Behind Pixar focuses on a target audience within a broad audience, similar to our study on Beyond Perception.

2.4 Museum Diversity

The American Association of Art Museum Directors conducted a study of diversity among United States’ museum visitors. Experts noticed this study and the significant lack of diversity in museum visitors. With this new knowledge, museums now have a “social contract” to fulfill. If museums do not address the diversity issues, they face the risk of becoming irrelevant (Levitt, 2015).

A diverse museum staff can play an important role in attracting a more diverse audience. A staff comprised of diverse backgrounds creates an inviting space for diverse visitors. Museums must serve a diverse public because they are funded by the public’s money. Museums face a need for performance measures based on patron satisfaction as highlighted by the diversity research (Goulding, 2000). Museums need diversity performance measures to gauge how successfully their exhibits appeal to multiple audiences.

Museums attempt to appeal to a broad audience by using interactive attractions. This does not address the cultural disparity, but helps expand
the age demographic towards a younger audience. Making changes to exhibits gives museums the opportunity to collect concrete physical data to determine how effective the changes were in engaging their audience. However, audience evaluation fails to account for visitors’ reactions to a museum’s presentation (Goulding, 2000).

The visitor experience can be categorized in three approaches; the social, the cognitive, and the environmental perspective. The social approach to visitor experience is the observation of the interaction between individual exhibit engagement and the social situation: by identifying how visitors’ experience correlates with their reaction to an exhibit. The second approach, the cognitive approach, explores the consumer’s motivations and classifies them as intrinsic and extrinsic motivations. Intrinsic motivations focus on internalized reactions such as the usefulness of the visit, the understanding of context, personal meaning, the opportunity to interact, and the degree of challenge presented to the participant. In contrast, extrinsic motivations focus on feedback and rewards such as tokens or privileges for achievement. The third and final approach is the environmental perspective of the visitor experience. The visitor’s behavior will always depend on their own motivations, but the spatial arrangement and ambiance of the environment will affect their interaction (Goulding, 2000). We drew from Goulding’s theory when assessing the relationship between Beyond Perception and its visitors.

2.5 Data Management Strategies

2.5.1 Visitor Data Collection

Museums have many avenues and methods of collecting data regarding visitor experience. They devote time and energy to finding the most effective methods of doing so, as reaching a broad audience is key to
maintaining their relevance and keeping visitors coming through the doors. It is important that we use only the methods that have proven to be the most effective in analyzing impact on visitors; such that we can understand the full scope of the impact that Beyond Perception has on its visitors and make the best possible recommendation for improvement.

One method, dubbed by Tucker, Bricker, and Huerta (2011) as the “survey techniques method,” utilizes direct visitor interaction through questionnaires, comment cards specific to each exhibit, or in-person interviews. These may ask the visitor to rate their interest in the subject of the exhibit or to respond to questions regarding the exhibit and about their likelihood to be interested in a potential future exhibit. The age and demographics of the person being surveyed are often included. This type of data collection allows for the museum or exhibit designer to understand who is attending the exhibit, and what that visitor’s impression was (Tucker, Bricker, and Huerta, 2011). The use of a survey to understand how the exhibit impacts the visitors is how we approached our project. How we did this can be seen in Section 3, and the survey can be seen in Appendix B.

2.5.2 Visitor Tracking

Often, exhibit designers choose to track visitors to measure their response to an exhibit. Visitor tracking refers to recording the path a visitor takes in a museum exhibit, including the time the visitor spends in different areas of the exhibit. Correctly modeling visitor paths in an exhibit includes noting which physical parts of an exhibit attract attention. Visitor tracking is a commonly used practice by museums investigating their exhibits. Traditionally, visitor tracking involves a museum official walking behind a visitor, at a distance, and recording the visitor’s path by marking it on a map. The visitor will have given consent to participate in the tracking before the experiment begins (Yalowitz and Bronnenkant, 2009). Visitor
tracking gives museums data about where visitors are spending time in an exhibit; this can be compared to the parts of the exhibit which were intended to attract the most attention. Engineers improved visitor tracking by providing electronic alternatives to the pen and paper method. Technological options for visitor tracking include Bluetooth devices, LAN wireless trackers, radio frequency systems, and other modern solutions (Rashed et al., 2017).

2.5.3 Bluetooth Technology in Visitor Tracking

The University of Melbourne partnered with Museums Victoria to pilot a study using Bluetooth visitor tracking technology. Museum researchers wanted to compare the motivation of visitors to their behavior at The Mind exhibit in the Melbourne Museum. In this study, researchers used newly developed Bluetooth beacons to track visitors inside of the exhibit. Researchers placed Bluetooth beacons near each of the major attractions of the exhibit and asked visitors to hold an Android phone, running custom software, as they walked through the exhibition.

The beacons tracked how long people spent near individual attractions. Researchers used a single or pair of beacons to track how long a visitor stayed at an attraction. The data acquired from the beacons gave researchers important insights about which attractions were acquiring the most attention, and the movement of the visitor between attractions.

Museum researchers identified the most popular attractions in the exhibit by noting which beacons were visited repeatedly by the same person. The researchers tested the technology in a period of trial and error before finding a system that allowed them to obtain meaningful data. The researchers noted that the Bluetooth technology “may provide a relatively efficient and cost-effective data collection strategy.” Bluetooth technology has the potential to provide museum researchers with “in time” updates on
exhibit conditions: crowd density, temperature, and other variables (Oliveira et al., 2018).

2.5.4 Visitor Tracking Ethics

Tracking and observing people comes with ethical implications. Research studies involving observations of people must purposefully protect the identity and integrity of the subject. This means either censoring identifying information from publications or providing anonymity to subjects during the research (Denzin, 1968). A museum’s code of ethics must reflect the societal space that museums exist in; this means respecting the “standards, values, norms, and philosophies” of their own mission and the society they belong to (Bounia, 2014). Currently, Museums Victoria’s code of ethics is under review (Ethics and Legal, 2018). When completing this project, we considered the societal context of Melbourne as well as the professional environment of Museums Victoria to make the appropriate ethical decisions.

2.5.5 Measuring Engagement

Visitor tracking is one method of measuring visitor engagement. Another measure of engagement is evaluating visitor tendencies in an exhibit. A museum must consider its unique needs and interests when formulating a visitor engagement study. Such a study can assess multiple criteria related to measuring engagement. Many museums choose to pair pre- and post-visit interviews with visitor tracking to qualitatively assess visitor engagement. However, this method fails to paint a complete picture of visitor experience (Tucker, Bricker, and Huerta, 2011).

Patrons react to museum exhibits in subconscious ways. Subconscious reactions are often indicated by facial expressions, body language, and verbal commentary. A visitor’s experience can be measured by the frequency, volume, and speed of their verbal reaction. An excited visitor
may tend to use similes and metaphors to properly communicate their enthusiasm (Baruch, Spektor-Levy, and Mashal, 2014). A visitor who is highly excited about their experience may tend to speak faster and louder than a visitor who is not engaged by the exhibit. Conversations with other visitors can also indicate visitor engagement.

The four levels of conversation are list, analysis, synthesis, and explanation. The latter three levels of conversation implicate higher levels of thinking about the museum exhibit, indicating that a visitor is combining the content of the exhibit with experiences from the outside world. Researchers have found that if a visitor partakes in any of the three higher level types of conversation, they are more likely to be engaged by the exhibit (Sanford, 2010). By measuring the types of conversation visitors engage in, museums can judge the impact of the exhibit.

Subtler than conversation, facial expressions can also indicate a visitor’s level of engagement toward the museum. Raising eyebrows, squinting eyes, rounded mouths, and pursed lips represent a person with high amount of interest in the exhibit (Jennings, 2009). Adults have more control over facial muscles than children. A person’s control over their facial muscles does not fully develop until adolescence. Therefore, children’s expressions are more likely to convey their true emotions, while adults can hide their feelings (Andrews, 2010). Control over facial muscles can complicate the assessment of engagement on adult’s faces. A visitor who is more active as they interact with the exhibit can be considered more engaged than a visitor who is stagnant (Sanford, 2010). By recording visitors’ facial expressions and movements, museums can try to evaluate levels of visitor engagement.
2.5.6 Analysis

One approach to data analysis is called the phenomenological approach. This approach seeks to find an underlying structure or reasoning for the data (Thorne, 2000). This method is applicable for giving a reader who has no experience in the field of research a better understanding of the phenomenon that is being explored. To use this method, all visitor data would be divided into populations before any analysis. Data would be grouped by age and compared only within a single age range. For the purposes of our project, this means splitting up visitor tracks and survey answers by age group, and comparing age groups instead of individual tracks or surveys. Using the phenomenological approach, we can compare tracking data to see if there are sections of the exhibit that are more engaging by identifying recurring patterns between samples.
3 Methodology

3.1 Objectives

The goal of this study was to assess the breadth of Beyond Perception’s current audience and make recommendations to tailor the exhibit to cater to all ages. To this end we:

1. Consulted with museum curators and museology research to identify precedent in exhibit tailoring and visitor data gathering;
2. Created a database of feedback on visitor needs and thoughts, as well as recorded observations of their behavior;
3. Evaluated impact and engagement of Beyond Perception across multiple demographics; and
4. Developed recommendations to widen Beyond Perception’s audience by analyzing data in the area of audience impact.

In this section, we describe our method to gather data from industry experts and Beyond Perception visitors, and to translate that data into final recommendations for Museums Victoria.

3.2 Survey

Originally, we planned to administer a survey as visitors left Beyond Perception (Appendix B). Visitors were asked if they wished to participate in order to obtain verbal consent. We used a script to approach visitors and inform them of our study (Appendix C). We attempted this method for a week, and many visitors declined the survey. After consulting with the museum’s Audience Insights staff, we chose to approach visitors while they were in the exhibit, rather than as they exited. This change made visitors much more likely to participate in our survey.

To administer surveys we spoke to visitors while they were in the
exhibit. We politely asked if they could spare a few minutes for a survey (Appendix C). We read the survey aloud and recorded visitor responses with a pen and paper. Parents with young children were often not able to answer all of the survey questions, on account of having to watch over their child. Any visitor who only completed part of the survey was still counted, for the questions they were able to answer.

### 3.3 Visitor Tracking

Visitor tracking revealed trends in exhibit visitor behavior. We intended to track every third person who entered the exhibit, however because of spikes and lulls in attendance, this changed. We tracked and observed every third visitor on days with high visitor density and every visitor on days with low visitor density.

A visitor’s path was recorded on a map of the exhibit using pen and paper as someone follows the visitor at a distance. Time spent at particular parts of the exhibit was measured using a clock with precise minutes and seconds. We compared visitor tracking data from a wide sample of visitors to identify patterns and connections between age groups and exhibit interaction.

### 3.4 Bluetooth Tracking

We utilized Bluetooth beacons (Fig. 1) provided by Eduardo Oliveira and his team from the McCoy Research Project “Understanding Reflective Learning Processes in Museums,” as mentioned in Section 2.5.3. The research was a pilot study that used Bluetooth tracking at Melbourne Museum. Oliveira generously allowed us to use his Bluetooth beacons, Android phones, and application for our project. We intended to use data from both the beacons and pen and paper tracking to analyze trends in
engagement, but also identify procedural differences between the two methods.

We asked each visitor who walked into the exhibit if they would participate in our study (Appendix C). If they gave consent, we would ask that they put one of the Android devices in their pocket for the duration of their time in Beyond Perception. The phone was running Oliveira’s application that decided which beacon it was closest to, and recorded the amount of time a visitor spent near that specific beacon.

The beacons were placed throughout the exhibit, so that each beacon could be correlated with a specific attraction in the space, while minimizing the amount of overlap between beacon ranges (Appendix D). The beacons were placed in areas of the space where they would be out of reach of children and blend into the exhibit. Some of the beacons were placed inside of walls, on top of mirrors, or on structural beams on the ceiling.

We intended to use Oliveira’s Python script to gather data from the Bluetooth beacons. This script parsed the resultant text file, making data much clearer and easier to analyze. However, due to various delays, we did not receive the parser by the time this report was written. In lieu of this, we wrote a more basic parser which a list of beacons in the order they were visited, allowing us to view a crude representation of a visitor’s path (Appendix J).
3.5 Informed Consent

Informed consent was obtained regarding observation and surveying from all participants. We posted signs at the ticket booths, information desk, and entrances of the museum to inform visitors about our study (Appendix E). As mentioned in Section 2.5.4, to conduct an ethical study we considered the societal context of Scienceworks. Scienceworks caters to many children and families. Museum patrons under the age of 18 are not legally allowed to give consent to participate in research studies. We did not track or survey any minors during the course of our research. We observed children when their parents were present and able to consent: even then, were made the parent the focus of our observations. Due to the ethical and legal implications regarding consent we did not track any minors associated with visiting school groups because they did not have parents with them to give consent to our study.

3.6 Observations

We used visual observation of visitors to measure engagement and shape our recommendations for Beyond Perception. We complimented tracking with observations because the amount of time a visitor spends near a particular attraction is not directly correlated with engagement. For example, someone could spend an hour reading and interacting with the exhibit, or an hour talking on the phone in the exhibit each representing a much different level of engagement.

Key indicators of social engagement are facial expressions, body language, and voice volume— as mentioned in Section 2.5.5. We recorded social behavior patterns in the “Notes” column of the tracking matrix included in Appendix F. We were able to categorize behavior and find trends within the exhibit. Originally, we had planned to record quotes from...
people’s conversations in the exhibit for use in our engagement analysis. However, when we began our study, we found this impractical because of the volume of the soundtrack and ambient noise at Beyond Perception (Section 2.5.5).

### 3.7 Legal Concerns

Worcester Polytechnic Institute (WPI) uses an Internal Review Board (IRB) to decide if any study involving humans is harmful or personally compromising for subjects. If the nature of a study is found to be safe to all involved subjects, a project can be exempted from the official process of the IRB. We applied for an exemption from the IRB because our project is not personally compromising. Our methods fell in line with the IRB rules and were approved by the time we arrived in Australia. In addition to WPI, Australian laws were followed to ensure our study was safe and legal. Following Australian laws meant ensuring all parts of the study were done with the legal consent of subjects.

### 3.8 Summative Evaluation

Museums Victoria tasked us with creating a summative evaluation report on Beyond Perception with previously collected data (Appendix G). The report prepared us with the necessary analytical methods we would need for our own data. The data consisted of the responses to a survey given to Beyond Perception visitors. Whereas our project focuses on Beyond Perception’s effect on different age groups, the summative evaluation sought to collect data on the general reaction to Beyond Perception. We used the summative evaluation report of another exhibit to model our direction for this task. This exercise familiarized us with the format of analyzing museum visitor data.
4 Findings and Results

4.1 About the Findings

After completing a visitor tracking and timing study, observational study, and survey, we analyzed data to find trends in visitor behavior. We measured the holding and attracting power of each attraction, and assessed visitor opinions on educational value, age appropriateness, and visitor preferences in Beyond Perception. We then categorized the recorded observations of visitor behavior. Finally, we evaluated the reliability of Bluetooth visitor tracking methods. In order to analyze the data, we used Microsoft Excel, Python, and Adobe Photoshop.

We collected data during the month of November 2018. During this time, some parts of the exhibit were not functional. The Mist Table, which is supposed to be part of the Turbulent Encounters display, was not functional at any point during our study. Therefore we were not able to include it in our observations. Additionally, one of the three infrared cameras in Turret 2 was not functional. However, we still collected data for Turret 2.

4.2 Visitor Paths

After completing 61 pen and paper tracks, we scanned each individual path into Adobe Photoshop. The image was cleaned up to remove any notes or smudges, resulting in an overlay of each individual path (Fig. 2).
The map of all visitors shows the strong attraction towards the right hand side of the exhibit, even with visitors entering from both the ramp and stair entrance. Visitors were most attracted to Turbulent Encounters, more specifically the interactive box containing the fans to blow around the styrofoam beads (Fig. 17). This could be due to the fact that it is a large, interactive exhibit that attracts attention from the movement of the beads, along with the case being in line of sight from each entrance.
4.2.1 Gender Comparison Maps

We collected visitor tracks for 25 male visitors and 36 female visitors. We compared the collection of male and female maps to investigate whether gender made a difference in someone’s path through Beyond Perception (Fig. 3). After comparison, there is no discernable difference in paths between genders.
4.2.2 Age Range Comparison Maps

We collected visitor tracks for visitors across a broad range of age groups. We categorized the tracks into four age ranges: teenagers, young adults, adults, and families (defined as at least one adult and one child) (Fig. 4). We collected visitor tracks for 6 teenagers, 9 young adults, 14 adults, and 32 families. The only difference in the age ranges is none of the
observed teenagers visited the Turrets.

4.2.3 Weekend vs. Weekday Comparison Maps

We collected visitor tracks over three weeks, including weekends. We collected 18 weekend tracks and 43 weekday tracks. Comparing weekend and weekday maps (Fig. 5), there is no clear distinction between the visitor path on the weekday versus the weekend, despite the trend that the weekends had a higher visitor density than the weekday.

4.2.4 Entrance Comparison Maps
We wanted to see if visitors paths depended on their entrance point. We collected 39 tracks that entered from the ramp entrance, and 22 tracks that entered via the stairs. There is no discernable difference between paths of visitors who entered from the ramp entrance or the stairs (Fig. 6).

4.2.5 Pen & Paper Heat Map

![figure 7: heat map of all tracks](image)

In order to discover the areas with the most visits, a heat map was created in Adobe Photoshop, by making a color gradient scale to represent
the amount of visitor paths that overlap (Fig. 7). A blue path indicates a single visitor’s path, while a red path indicates six visitors’ paths overlapping. This map indicates the paths visitors took, and not the time spent at each attraction.

4.3 Visitation Patterns in Beyond Perception

The data collected from each visitor track was recorded on a visitor tracking matrix (Appendix F). We collected a total of 61 visitor tracks. We analyzed visitor tracking data to find trends in behavior. We identified the average visitor’s path and time in each attraction. We calculated the repeated visitation of each attraction. To compare the effectiveness of the exhibit, we calculated the holding and attracting powers for each attraction.

4.3.1 Summary Statistics

The average time visitors spent interacting with the exhibit was 11 minutes and 19 seconds. Interaction time does not account for transit time, defined as the time the visitor is walking around from feature to feature. Average total duration, including transit time is 11 minutes and 46 seconds. This means that the average visitor spends less than 30 seconds in transit, indicating that most of a visitor’s time is spent interacting with the

Figure 8: Visitation Pattern by Attraction
attractions.

The average visitor would spend the most time at Turbulent Encounters and the least time at the stair entrance (Fig. 9). The attraction with the least average time duration is Turret 1. The time durations range from 2 minutes and 47 seconds to just 5 seconds.

4.3.2 Repeat Visitation

Repeat visitation was calculated by summing the number of visits to each attraction from all visitors, and dividing by the total number of visitors. A visitation score of over 100% means a visitor was likely to visit the attraction more than once during their visit.
We compared visitor patterns by age group (Fig. 10). Turbulent Encounters has the highest visitation rate, for all age groups. Cacophony, Turbulent Encounters, the Studio, Cosmic Events, and Waves at Work have approximately equal visitation rates for adults. The Force Plates and Turbulent Encounters were most popular with Beyond Perception’s target audience, teenagers. Cacophony and Turbulent Encounters were most popular with families and elders. Turret 1 and Turret 2 had the lowest visitation rates for all demographics.

4.3.3 Attracting & Holding Power

Attracting Power

Attracting Power is a metric that shows the number of times an attraction is visited (Fig. 11). It reveals the portions of the exhibit that visitors are most attracted to, but does not consider the amount of time
that is spent there. Attracting power is calculated by taking the total number of visits, finding the average and subtracting each attraction’s visits from the average. Turbulent Encounters, Cacophony, and the Studio have high attracting power. Cosmic Events, Force Plates, Waves at Work and Energetic Vibrations have medium attracting power. Wrapped in Spectrum, Turret 1, and Turret 2 have low attracting power.

Holding Power

Holding Power is a similar metric to attracting power that is used to determine the effectiveness of an attraction or an exhibit to keep a visitor engaged (Fig. 12). This is done by taking the average of all total time spent at each attraction, then subtracting the total time spent at that attraction from the average. Any attraction that has a large positive difference, like Turbulent Encounters, Energetic Vibrations and the Studio, have a high holding power. Attractions that have a small positive or negative difference,
like Cacophony, Cosmic Events, Force Plates and Waves at work have a medium holding power. Any attractions that have a large negative difference from the average, like Turret 1, Wrapped in Spectrum, and Turret 2 have a low holding power. Exhibits that have a high holding power will have visitors more engaged and interacting with the exhibit.

In Beyond Perception the attractions that are more interactive, like Turbulent Encounters, have both high holding (Fig. 12) and attracting power (Fig. 11). The attractions that were based on an audio/visual experience, like Wrapped in Spectrum have low attracting and holding power. The exhibits that had a combination of audio/visual and interactivity, like Cosmic Events and Waves at Work had both medium holding and attracting power.

4.4 Visitor Surveys

We collected 30 survey responses from Beyond Perception visitors (Appendix B). We gathered data on the perceived educational value of Beyond Perception and how a broad audience viewed Beyond Perception. When analyzing survey data, we compared variables to discover visitor’s opinions on the educational value, age-appropriateness, and preferences in Beyond Perception.

4.4.1 Educational Value Assessment

After learning of Shearer’s intended behaviour model for Beyond Perception visitors (Section 2.2.2), we wanted to test if visitors were coming out of the exhibit feeling as though they had learned a lot of new material. When asked to rank the overall educational value of Beyond Perception, the mean rating (accounting for outliers) was 7.66 out of a possible score of 10. More than half of the respondents ranked the category with a score of 7 or higher.
The mean rating for the respondent’s desire to learn more about science was 7.55 out of a possible 10, the histogram of this data is distinctly left skewed. When asked for the ranking of the amount of new things respondents learned from Beyond Perception, the mean ranking (accounting for outliers) was 6.32 out of a possible score of 10, the graph of this data (Fig. 13) is slightly skewed right.

Shearer hoped Beyond Perception would spark a curiosity about science in visitors, rather than present them with lots of facts. The statistics suggest something different is happening, because the score of desire to learn more about science is the lowest of the three. A comparison of all three data sets (Fig. 13) shows that all three data sets have large ranges, suggesting a lack of consensus from respondents. The comparison of the three ranking questions suggests that Beyond Perception is not perceived as having a substantial educational impact.

4.4.2 Exhibit Attraction Preferences

We inquired as to what visitors preferences were inside of the exhibit. Most visitors cited either Turbulent Encounters or Energetic Vibrations as their favorite part of the exhibit. One survey respondent cited Turbulent Encounters because her young son was “mesmerized by it.” The question about visitors’ least favorite part of the exhibit saw a broader range of responses. Some visitors cited the labels on the walls as their least favorite part of the exhibit, because they were either hard to read or hard to follow.
Other visitors claimed that they weren’t sure what to do with some of the interactive activities in the exhibit, such as someone who said “I can’t figure out how the black holes work” (referring to Cosmic Events).

We asked visitors to describe Beyond Perception, as if they were describing it to someone who had never seen it before. Sixteen visitors gave positive descriptions, four visitors gave neutral descriptions, four visitors gave “other” types of descriptions, but no visitor described Beyond Perception negatively. One visitor responded saying that they did not know how to answer the question because their description “would depend on the age of the person.” Words that visitors used to describe the exhibit included “beautiful,” “relaxing,” “trippy,” and “fun.”

4.4.3 Age-Appropriateness Evaluation

We also investigated which audience respondents thought Beyond Perception was best suited for. Figure 14 depicts the data collected from this survey question. Teenagers, the target audience, were most often listed as an appropriate audience for Beyond Perception. Figure 14a is a pie chart that depicts that the vast majority (82.8%) of respondents thought the exhibit was appropriate for teenagers, its intended audience. Young adult and child, the nearest categories to teenager, were equally ranked as the 2nd most appropriate category. 86.2% of survey respondents found that the exhibit was appropriate for their own age group.
4.5 Observational Study

To evaluate the behavior of museum visitors at main attractions within the exhibit, we conducted an observational study at the Turrets (Turret 1 and Turret 2), Wrapped in Spectrum, Turbulent Encounters, Force Plates, Energetic Vibrations, Cosmic Events, Studio, Waves at Work and Cacophony. The study identified the interactions each visitor had with the attractions and helped our group categorize their behaviors. For each area, the team took note of what occurred and if the visitor displayed any notable behavior towards the exhibit. Each visitor’s interaction allowed us to see if each attraction was being used for the intended purpose.

4.5.1 Turrets

The first turret is located on the ramp side of the exhibit (Fig. 15a). The second turret is located on the opposite side of the first towards the stair entrance (Fig. 15b). These attractions are a significant distance from the main portion of Beyond Perception. The first turret is a real time interactive forecast map of the globe that lets the user see the patterns of wind where they please. The other turret is similar to the first, but is a camera providing a filtered image of the museum visitor often displaying something silly or colorful.
These attractions received a low number of visitors. Those who did go to this attraction would interact with the map and camera, yet did not stay for long. The Turrets did not attract the same amount of visitors as some of the other attractions, but those who did find this attraction enjoyed it thoroughly.

4.5.2 Wrapped in Spectrum

Wrapped in Spectrum is the first main attraction in Beyond Perception. This attraction serves as a welcome to the space and provides information about different types of wavelengths. Wrapped in Spectrum is laid out as a long hallway with 8 bright screens on the wall of the attraction (Fig. 16).

Museum visitors interacted with this attraction in a different way than what was intended. Many visitors mistook these as touch screens. Visitors would poke, touch, or prod the screens until they realized they were not
interactive. The constant touching and hitting of the screen leaves the image distorted for a while until it refreshes. There was a minority of people who stopped and read each screen with the intent to learn something from the attraction. Those who did take the time enjoyed the information, colors, and educational value of this attraction.

4.5.3 Turbulent Encounters

Turbulent Encounters is one of the main attractions in Beyond Perception. This attraction is a large glass box with 4 fans located at the bottom of the box at each corner (Fig. 17). The glass box was filled with thousands of white beads illuminated by a calming blue light that shined down from the top of the box. This attraction was the best lit in Beyond Perception and based on our findings caught the attention of many visitors as the entered. We observed that many visitors used the interactive feature creatively by turning the fans on and off as if playing a game to watch the beads swirl.

We observed that only few people read the wall descriptions and watched the explanatory videos. Visitors who actually did inform themselves using the provided information all used the interactive features of Turbulent encounters and enjoyed the experience. Some of them returned for a second or even third encounter.

4.5.4 Force Plates

The Force Plates attraction is based on the concept of fluid mechanics. This attraction is located in the same space as Turbulent Encounters. This interactive feature share the space and complement each other nicely to
attract and keep visitors in their space. The Force Plates allowed museum visitors to manipulate a digitized version of a liquid on a screen and manipulate its flow using various knobs (Fig. 18).

![Figure 18: Force Plates](image)

Visitors could turn the direction of the liquid by using the knobs on each of the screens. Based on our observations, kids and adults enjoyed the interactive element to the Force Plates. They often played together for a substantial amount of time. Because the Force Plates were in proximity to Turbulent Encounters, many visitors would alternate between the two attractions.

### 4.5.5 Energetic Vibrations

Energetic Vibrations provides a lounge area for the visitors, where they can lay on three couches that vibrate to different preset patterns (Fig. 19). Visitors are intended to relax on the vibrating couches, while they appreciate the projection on the wall.

![Figure 19: Energetic Vibrations](image)

Some visitors did not notice that the couches vibrated and often passed by them. There was a significant number of people who did notice and lied down or sat on the couches. These visitors would be laying down or sitting there for a long period of time, in one case up to 40 minutes. The people who laid down found that this second lounge area was much more relaxing than the Cacophony area.
4.5.6 Cosmic Events

Cosmic Events is an attraction that lets visitors interact with the physics of black holes. It features several sheets of soft stretchy mesh material with animations of black holes and outer space projected onto the sheets. This is an interactive attraction that lets the user touch the covered up hole to simulate a black hole (Fig. 20).

After the observational study, we saw that a minority of people read the description and video on the wall detailing the science and reason behind Turbulent Encounters. It attracted less visitors than expected and often many of the visitors would walk right by the attraction: without noticing it was an interactive. There is some confusion with the visitors recognizing the Cosmic Events attraction as a interactive due to the fact that most think of it as an image and not something they can touch.

4.5.7 Studio

The Studio is a collection of synchronized tablets and projectors. Museum visitors can sit down and create artistic images with pairing beats on the tablets and then watch their creation be projected. These images and beats are projected on a pillar that is centralized between the studio devices. The
Studio inspires creativity from all ages giving all the opportunity to make different shapes with colors and experiment with musical studio concepts to make this attraction fun and interactive (Fig. 21).

The observational study showed us that kids and young adults tended to go right into the interactive, Whereas the older adults would rather go to the description wall and read about the different musical concepts displayed. The adults who did go in the studio followed their children. Families collaborated together in the Studio to create their own projections. Overall, the studio attracted a good amount of museum visitors and let families interact together and have fun.

4.5.8 Waves at Work

The attraction teaches visitors about microscopes by using diagrams, text on the wall, and videos (Fig. 22). The space is occupied by eight tall mirrors. The path through the mirrors was rather short and would not maintain visitors in the space for long. Many visitors would walk into the space in the middle of a video, and would walk out because they did not see the first half of the video. Children often played and ran around in the mirrors, while adults were more likely to pay attention to the script on the wall or watch a video.

4.5.9 Cacophony
Cacophany consists of multiple couches underneath mirrors, with projections of rainbows and water drippings moving throughout the space (Fig. 23). Almost all visitors passed through Cacophany at one point during their track, because it acts as a hub to the other areas of the exhibit. Our observational study showed that most people used Cacophony to have a social moment; they sat, talked, laughed, and took selfies on the couches. We did not notice any differences in behavior in different age groups. People would often come back to Cacophony to socialize before exploring other parts of Beyond Perception.

4.6 School Group Observation

Although we were not allowed to track school groups, we were often collecting data from other visitors while school groups occupied the exhibit. School kids would often collect on the couches in Cacophony or Energetic Vibrations, before moving to another part of the exhibit. They would collect together after interacting with the exhibit to talk and take selfies before moving onto another part of the exhibit. Most of them used the exhibit as a social space where they would explore science by using the interactive parts with their schoolmates. The general trend of the school groups followed Shearer’s “social moment and then explore” model.

4.7 Bluetooth Tracking Results

After learning about the existence of Bluetooth technology and the prospect of using it for our project, we met with Sandra Carluccio, who works in the exhibitions department at Scienceworks, and discussed locations for placing
the Bluetooth beacons such that we could collect the most accurate and
correct data. She then put them up throughout the exhibit using some
heavy duty double sided tape, and we began doing some test runs on the
beacons ourselves.

4.7.1 Bluetooth Tracking Issues

Quickly, we found that a few of the beacons she had placed were behaving
strangely. The two that were placed in the Turrets could not be connected
to at all. We thought that the issue could be attributed to the fact that
both beacons were located merely a few inches away from a security camera
which could have been causing interference. Another issue that we
encountered is that throughout the exhibit the android devices would
occasionally display unique IDs that we did not recognize as being one of
our beacons. We contacted Oliveira regarding these issues, and he advised
that we try changing the location of the beacons. We did so and found that
with the updated locations of the Turret beacons, we could then connect to
those correctly. However, the connections were still spotty and there seemed
to be a lot of noise in the data.

At this point, we began handing phones out to visitors to collect some
data. However, in several cases, the devices we handed out were returned
with no data at all. We don’t know why this happened, although we think
it may be because the device’s power button was bumped by the visitor
causing it to lock and to stop collecting data. In some cases still the data
was cut short and only represented a portion of the visitor’s actual path
through the exhibit. When we did get a full track’s worth of data, upon
review it was often incorrect when compared to our general observations of
that visitor’s behaviors. We are not totally certain what was causing these
issues, but we speculate that other technology within the exhibit and the
rest of the museum could have been causing interference.
4.7.2 Comparison Study

In light of the problems we experienced, we decided to conduct a brief experiment to compare the accuracy of Bluetooth and pen and paper tracking. In order to do so, two of our group members carried Android devices along a simulated path through the exhibit while being tracked on paper by the remaining two group members. We found the results of this experiment to be indicative that the data collected from Bluetooth tracking in Beyond Perception is unreliable.

**Pen & Paper Order**
- Stair Entrance
- Turbulent Encounters
- Energetic Vibrations
- Turret 1
- Ramp Entrance

**Bluetooth Order**
- Turbulent Encounters
- Energetic Vibrations
- Turret 1
- Cacophony
- Cosmic Events 1
- Studio
- Stair Exit
- Cosmic Events 2

Figure 24: Comparison of Bluetooth to Pen & Paper Tracking

As one can see in Fig. 24, there are several discrepancies between the pen and paper and Bluetooth maps. For one thing, the tracks neither begin nor end in the same location. Furthermore, they do not list the same quantity of locations. While some locations are correct, the nature of visitor tracking requires the data to be precise, and Bluetooth tracking simply does not seem to satisfy this need.
5 Conclusions and Recommendations

5.1 Exhibit Attraction Based on Analysis

5.1.1 Turrets

The Turrets were not as popular as other parts of Beyond Perception, as they ranked lowest in terms of attracting power (Fig. 11). Turret 1 ranked the lowest in terms of holding power, as well. Turret 2 ranked 3rd lowest in terms of holding power; however, it had more than double the holding power of Wrapped in Spectrum, which followed it on the list. A more detailed analysis shows that the Turrets were most popular with families, teenagers, and young adults, and least popular with adults. One survey respondent listed the Turrets as their least favorite part of the exhibit, stating that it was not cohesive with the rest of Beyond Perception. Visitors that did enter the Turrets behaved as intended (Section 4.5.1).

We recommend increased visitor guidance around the Turrets. Most visitors would walk by the Turrets while they were in Beyond Perception and not enter them. We recommend extending the light projection along the ramp entrance to the Turrets, as visitors would likely tend to follow the projections on the floor. Also, we recommend a revision of the content of the Turrets. Most visitors failed to see the connection between the wind map and Turbulent Encounters or the infrared camera and light-based part of Beyond Perception.

Adding a caption to Turret 1 reading “Turbulence and Wind: Touch this map to see real-time wind patterns. See more in Turbulent Encounters.” will tie this Turret to Turbulent Encounters (Fig. 25a). Adding a caption to Turret 2 that reads “IR Light: Cameras can see this type of light, but not the human eye. Learn more about this in Wrapped in Spectrum (in the hallway)” (Fig. 25b). Making the content of the Turrets
directly match with the rest of Beyond Perception would help their cohesiveness with the rest of the exhibit. Overall, we recommend to revise the content of the Turrets and include indicators of their position in Beyond Perception.

![Turret Recommendations](image)

(a) Turret 1 Recommendation  
(b) Turret 2 Recommendation

Figure 25: Turret Recommendations

### 5.1.2 Wrapped in Spectrum

Wrapped in Spectrum was also not as popular as other parts of Beyond Perception. Wrapped in Spectrum showed low holding power and low attracting power. However, it did display more attraction power than holding power (Fig. 11, Fig. 12). A more detailed analysis shows that Wrapped in Spectrum was most popular with young adults. Also, visitors did not behave as intended with Wrapped in Spectrum. Many visitors tried to interact with screens that were not touch screens, which would result in a visitor losing engagement and walking away.

We recommend a revision to the display of information at Wrapped in
Spectrum. A possible method to increase holding power would be to make the screens interactive. When a visitor touches a screen they will not be disappointed and walk away but would hopefully continue to interact with the attraction. This can be seen in Fig. 26. Another possible change to Wrapped in Spectrum, which would correct the behavior of visitors, would be to indicate that the screens are not interactive. With a small indicator or script on the wall, telling visitors to “please not touch the screens”, hopefully less visitors would poke the attraction, With less people poking the screens, the longevity of the screens would be increased.

5.1.3 Turbulent Encounters

Turbulent Encounters was a very popular part of Beyond Perception. It had both the highest holding and attracting powers of all the attractions in Beyond Perception. Turbulent Encounters was most popular with teenagers. Visitors behaved as expected, with adults helping children understand the interactive aspect. The attraction was also the part of Beyond Perception that was visited multiple times, at the highest rate. Turbulent Encounters was listed as survey respondents favorite part of Beyond Perception the most. We consider the attraction to be a very successful part of Beyond Perception and do not have any recommendations for change.

5.1.4 Force Plates

The Force Plates were a moderately popular part of Beyond Perception. They had mid-range attracting and holding power. An analysis of our visitor tracking maps shows that the Force Plates were most popular with families. Visitors behaved as intended at the Force Plates: older visitors would help younger visitors with the interactive knobs and people would talk with each other as they used the interactive. The Force Plates were moderately successful, but not as successful as Turbulent Encounters. The
two attractions are right next to each other, yet have very different attracting and holding powers.

Our recommendation for the Force Plates is to add script on the wall above or below the knobs. The script should tell visitors about fluid mechanics and what they are simulating with the knobs. Turbulent Encounters is more popular because people interact with air flow (wind) every day. People would not as easily recognize Newtonian fluid mechanics. Adding a description of the simulation would help visitors relate what they are manipulating with the attraction.

5.1.5 Energetic Vibrations

Energetic Vibrations was moderately popular among the Beyond Perception audience. Energetic Vibrations had high holding power, but low attracting power. The attraction was most popular with families. When asked what their favorite part of Beyond Perception was, seven survey respondents named Energetic Vibrations, or more specifically the vibrating couches in Energetic Vibrations. The visitors who did visit Energetic Vibrations behaved as expected: using the couches to sit and talk, while a minority of visitors watched the videos or read the wall script.

We recommend trying to increase the attracting power of Energetic Vibrations by enticing visitors to sit on the couches. Energetic Vibrations would be more popular if visitors were enticed to try the vibrating couches.
Projecting something on the floor of the space would attract visitors toward the couches. We designed a graphic of this (Fig. 27).

5.1.6 Cosmic Events

Cosmic Events was a moderately popular attraction with the Beyond Perception audience. The attraction had mid-range holding and attracting powers. A deeper analysis shows that Cosmic Events was most popular with adults and families. Some visitors did not behave as intended in the attraction because they did not interact with the black hole projections.

Our recommendation for Cosmic Events is to include directions to the black holes. Doing so will increase holding and attracting powers of Cosmic Events by inviting visitors to manipulate the interactive parts of the attraction and having them take a moment to digest what the projection is trying to teach them. A revision to Cosmic Events could be a drawing that encourages visitors to touch the screens. Labeling the black holes as an interactive part of the exhibit would correct the unexpected visitor behaviors and increase the holding and attracting powers. Our revision for this attraction can be seen in Fig. 28.
5.1.7 Studio

The Studio was a moderately popular part of Beyond Perception. The Studio had the third highest attracting and holding powers. A deeper analysis shows that the Studio was most popular with teenagers. Visitors behaved as intended in the Studio. Visitors of all ages would interact and manipulate the screens and lights. The Studio was also listed as some visitors favorite part of Beyond Perception. We consider the Studio to be successful part of Beyond Perception and have no recommendations for change.

5.1.8 Waves at Work

Waves at Work was moderately popular with the Beyond Perception audience. It had a medium attraction power and low holding power. The attraction was most popular with teenagers. Visitors in Waves at Work did not behave as intended, most adults would not stick around the area to watch or listen to videos. Children preferred to play in the mirrors than pay attention to videos or the script on the wall. Waves at Work also was listed as a favorite and a least favorite attraction on visitor surveys.

Our recommendation for Waves at Work would be to redesign the layout of the space to be more suitable for a broad audience. We recommend keeping the mirrors, because children enjoyed having them in the area. However, we suggest reducing the number of mirrors and possibly
moving them to increase the area around the large video screen. Adding seating around the screen would also entice more visitors to sit and listen to the videos. The attraction map reflecting this recommendation can be seen in Fig. 29.

5.1.9 Cacophony

Cacophony was very popular with the Beyond Perception audience. Cacophony has a high attracting power and medium holding power. An analysis of our visitor tracks shows that Cacophony was most popular with families. Visitors behaved as expected in Cacophony. Many visitors used Cacophony as a social space. Cacophony was listed by multiple visitors as their favorite part of Beyond Perception during surveys. We consider Cacophony to be a successful part of Beyond Perception and don’t have any recommendations for change.

5.2 Design Analysis

5.2.1 Fulfillment of the Original Intentions of Beyond Perception

Shearer intended Beyond Perception to ignite an interest in STEM and be a social experience for visitors (Section 2.2.2). Survey results lead us to believe the educational goals were partially fulfilled. The average survey response for the question about having an interest in research after Beyond Perception had the lowest average score. However, survey respondents did say that Beyond Perception had an educational value of 7.66 out of 10, on average (Section 4.4.1). The education-based intentions for the space were partially met, but could be improved with some recommendations (Section 5.1).

We saw evidence of the social experience aspects of Shearer’s intention in many different age groups. School groups, which often consisted of
Beyond Perception’s target audience, would collect for social moments before exploring different parts of the exhibit (Section 4.6). We saw all age groups use Cacophony as a social space, where they would come together with members of their group before visiting new parts of Beyond Perception (Section 4.5.9). We also saw many visitors use Energetic Vibrations as a social space, and sit and talk to each other while interacting with the Studio (Section 4.5). Shearer’s social intentions for the space were met. Many demographics, including the target audience, use Beyond Perception as an informative space, as well as a social space.

5.2.2 Interactive vs. Audio/Visual Elements

In all of the data, it is clear the right side of Beyond Perception has the highest visitation, engagement and is the preferred side of the exhibit. This is due to the interactivity of these attractions. Beyond Perception was designed to bring invisible forces to life, and this is done very well on the right hand side of the exhibit. Turbulent Encounters is the crowd favorite attraction because of its interactivity, and its relevance to life. Turbulence and wind are things that people will experience every day in their life, so seeing it in a new way and being able to play with it allows people to understand the direct effect they have on it.

Comparing this to the Cosmic Events, no visitor has experienced black holes. The black hole screens provide an experience that is engaging, but hard for people to understand. The Energetic Vibrations and Studio are based on sound waves, which is something that almost everyone has experienced. Once people discovered that the couches in the attraction vibrated with the music, they were more likely to spend a lot of time enjoying that portion of the exhibit. The Studio also had a high visit percentage, and a long interaction time. Being able to experience sound in a new way provides visitors with an attraction that is engaging and relatable.
The Waves at Work attraction has an recognizable topic but is presented in an ambiguous way. The video being played has attractive visuals paired with audio commentary. The audio and visuals have the potential to make Waves at Work an immersive attraction, however, the layout of the area distracts visitors from its content.

In Beyond Perception the attractions that are more interactive, like Turbulent Encounters, have both high holding and attracting power (Section 4.3.3). The attractions that were based on an audio and visual experiences, like Wrapped in Spectrum have low attracting and holding power. The attractions that had a combination of audio/visual and interactivity, like Cosmic Events and Waves at Work, had both medium holding and attracting power.

Attractions that were interactive saw visitors spend more time there. For Beyond Perception, it was hard for visitors to tell what parts of the exhibit offered interactivity and what was meant to be a visual. Improving the signs or making graphics that indicate something happens when the visitor interacts with the exhibit will not only increase holding and attracting power, but will improve the overall visitor experience at Beyond Perception.

5.3 Method Analysis

5.3.1 Bluetooth vs. Pen and Paper

When comparing the methods that we used for data collection, there are three criteria that make up the overall effectiveness of each method:

- Ease of use
- Reliability
- Analysis required

When it comes to ease of use, pen and paper is superior to Bluetooth.
The only setup required for pen and paper tracking would be printing out maps and tracking matrices and putting them on clipboards. From there, the only thing that needs to be done is observing. Bluetooth tracking, however, took several email correspondences, a meeting with Oliveira, and several iterations of putting up the beacons and testing, and we still were not fully satisfied with the results we got from it. It likely would have taken another few iterations and significantly more testing before we had everything set up perfectly.

We found that pen and paper tracking also wins in the reliability category. As mentioned in Section 4.7.1, we found the data we collected from Bluetooth to be spotty and generally less reliable than the data from pen and paper tracking. Frequently the devices we handed out to visitors would return with unrecognizable unique IDs, or simply no data at all in some instances. The only issue we could foreseeably encounter with pen and paper tracking would be if we lost track of the visitor and could not find them in the exhibit for a period of time, which is an issue that we never encountered. We found that pen and paper tracking yielded much more reliable and accurate results than Bluetooth tracking.

For pen and paper tracking, our analysis consisted of taking a look at the maps we had created, the average time spent, and the number of times visited for each portion of Beyond Perception. We also scanned each map into Adobe Photoshop and overlayed them based off of different criteria to show trends in the data. While this did require some analysis in Microsoft Excel as well as some work in Photoshop, it was far less involved than the analysis of the data acquired from Bluetooth technology.

Bluetooth data was automatically stored in a text file (Appendix H) which needed to be analyzed. As the beacons sent a signal every 300 milliseconds, the text files got quite large and quite messy very quickly. In order to understand the data, a parser needed to be written. This can be
very time consuming and complicated, as it must trim out outlying data as well as accumulate the amount of time spent at any certain portion of the exhibit. We hoped to use the parser that Oliveira used on the McCoy Project, however we had not received it at the time that this paper was written. We created a much simpler parser which reported the order in which the attractions were visited for a very basic analysis, but did not create one that mirrored the functionality of Oliveira’s parser due to time constraints. Even if we had Oliveira’s parser, we would then need to experiment with data visualization libraries such that we could represent the data in a profound way. In conclusion, pen and paper wins again with the amount of necessary analysis.

Bluetooth technology represents a method of tracking with huge potential for impact in a museum setting. Since using this technology for tracking was more of an afterthought in the context of this project, we were not able to collect much data using the technology that’s worth much at all. However, after experimenting with the location of the beacons and manipulating the technology within Beyond Perception, it is evident that there is potential for Bluetooth to be a huge tool in the world of visitor studies. We believe that it would be well worth it for a future project (perhaps a WPI Interactive Qualifying Project [IQP]) to devote more time into exploring the potential of Bluetooth tracking.

5.4 Recommendations for Future IQPs

After completing our study for the Beyond Perception exhibit, we came up with some improvements to the survey and tracking and timing methods that we developed during our IQP. The team has compiled recommendations based on our IQP that would help future studies with their methods.
5.4.1 Survey Methods

We found great success in mingling amongst Beyond Perception visitors to administer surveys. At first, we attempted to do so by standing at each exit to the exhibit and asking visitors as they left if they would fill one out. However, visitors frequently declined due to a scheduled show or tour they were going to. By giving out surveys when visitors were in Beyond Perception, we saw a much higher rate of respondents agreeing to take the survey. We would also recommend distributing surveys during the same period as visitor tracks. We spent three weeks tracking visitors, and then surveyed visitors over the course of a week. The amount of surveys gathered would have been higher had two team members been tracking while two team members gave out surveys. We recommend this model to future IQP teams to improve data collection.

5.4.2 Tracking and Timing Methods

We tracked 61 visitors, of varying age groups, and were never confronted for disturbing a visitor’s experience. We wore our Museums Victoria Intern ID cards whenever we were in Beyond Perception to mark us as staff. We also wore dark clothing to help us blend in. During our first few tracks, we identified central points in the exhibit to sit while we wrote notes. The central points were couches and benches with views of most of Beyond Perception. We recommend other IQP teams use similar methods to ours when visitor tracking because we were able to discreetly gather data without disturbing anyone.
6 References

This article highlights some of the Melbourne Museum’s most attractive exhibits. The article details specific exhibits and their unique focuses. It mentions that the museum moved to a larger space in the year 2000, after being closed for three years. The article does not mention specific attendance rates for these exhibits, or any demographic information of the visitors.
We can use this article to give perspective on the topics of the Melbourne Museum’s successful exhibits. The list is a very diverse group of exhibits: targeting a broad range of audiences and covering a broad range of topics. We can use this article to make a comparison of Beyond Perception to other successful exhibits. This article will be used as a springboard, to research the list of exhibits individually to use as quantitative comparison: based on attendance numbers and demographic information. (Page 5).

Mark Andrews’ article from Scientific American focuses on the theory behind facial expressions. He uses the facial expressions of infants as an example of some intrinsic expressions of humans. Andrews argues that facial expressions are a form of communication between people. This piece gave us the crucial piece of information, that we should be observing facial expressions. The major limitation of the piece is that it does not correlate specific facial expressions with specific emotions; it simply states that they are important. (Page 14).

Arinze’s public lecture defined the function of modern museums. The work provided a basis for the position of museums in society, which acted as an introductory platform of our work. The latter half of the piece is specific to the state of museums in the nation of Guyana. However, the prior half of the piece is applicable to museums in society in general. We will use this piece as a primary source for our background section, to speak to the significance of museums. (Page 3).


Baruch’s journal article classified verbal and nonverbal behaviors of pre-schoolers as they related to interest in STEM. The study observed 41 pre-schoolers behavior and found connections between certain behaviors and interest in science. We used this article to help research behaviors we should be looking for in young museum visitors. (Pages 1, 14).


Bounia discusses ideologies regarding the ethics of research in museums. He claims that museum research is acceptable so long as the identity and reputation of the subjects are not compromised in any way. He goes on to state that since ethics are the crux of museum research, they should be embodied in every policy or procedure that is created by museums in
order to uphold the integrity of the morality of that museum. The major limitations of the work is that it does not discuss the morality of studying minors, which we will need to do for this project. (Page 13).

The Boston Museum of Science focuses on museum diversity and the impacts of exhibit designs in their PIXAR study. This source provides a summative evaluation on the critical questions that the organizations wanted to get answered. The report and methods used will be a strong comparable point to that of Beyond Perception due to the similarity of the studies. We will use this study as a guide for our project in improving Beyond Perceptions. The study is limited by being focused on reaching children with disabilities, instead of the broad audience we will evaluate for Beyond Perception. (Page 9).

Carliner compares museum practices to formal education and shares eight primary lessons he concluded from his study. He analyzed museum practices with his background in education. Carliner writes about targeting exhibits to audiences, differentiating an exhibit from “a book on the wall”, and how teams of educators and museum experts collaborate to bring exhibits to life. Under each of the eight headlines, Carliner lists his observations, provides his analysis, and gives recommendations for the use of technology in museums (a growing initiative in the realm of education). Carliner’s article views exhibits as sources of informal education, but not does discuss how to revise unsuccessful exhibits. He fails to suggest methods of assessment and redesign for exhibits. Carliner’s work is
limited by being based on observational research; he did not interview or survey any museum visitors or employees. The other major limitation of Carliner’s work is that he provides suggestions for consideration and change, but doesn’t actually try any of the practices he mentions.

Carliner’s article can be of use to our team. We can use Carliner’s article to make sure any suggestions we make will uphold the educational validity of the exhibit. We can use Carliner’s observational studies as the basis of comparison between our sponsor and other world renowned museums, providing perspective for our project. We have yet to design specific protocol for our observational studies, so our team can take inspiration from Carliner’s methods during our project. (Page 4).


Csikzentmihalyi and Hermanson review the environment based educational literature. They view learning as a process of experience and discovery, rather than the absorption of knowledge in a classroom. They discuss how a museum must be attractive to its audience. We will use this work to aid our understanding of how Beyond Perception could be attraction to a broad audience. The literature is limited by being a combination of solely theoretical studies, without any practical applications. (Page 4).


The main idea of this article is to censor all identifying all information in publiciations. This article was used for developing and learning about the ethics of tracking subjects. Due to its age, it is limited, however still has important information that needs to be taken into consideration when doing a study. (Page 13).
Ethics and Legal (2018). URL:
This is the official ethics website of all Australian museums. This website provides access to all current legal and ethical codes for each Australian museum. At the time of this project, Museums Victoria was revising their code of ethics and we were not privy to it. (Page 13).

Flanagan, J.C. (1982). “Measurement of quality of life: current state of the art.” In: Archives of Physical Medicine and Rehabilitation 63.2, pp. 56–59. Flanagan sought to find specific factors that affect the quality of someone’s life. He found that education is one of the most important factors in life quality, and is hardly satisfactorily fulfilled. Other important factors in quality of life are health, participating in government, and creative expression. Beyond Perception does not fulfill any other significant factor except education, therefore we are limited in our application of Flanagan’s study. This study is relevant to our work because it speaks to the relevance of museums in modern society. Museums are a form of education, and education is an important factor in quality of life. (Page 4).

Jeffery Forgeng is the Arms and Weapons Curator of Worcester Art Museum. He talked to Gomes and Pierce about the methods WAM uses when considering visitor studies. He discussed the issue of no standard method of visitor evaluation that all museums face. Forgeng explained the constant process of redeveloping exhibits to improve visitor experience, and provided an example of how he was doing this with a current installation. (Page 7).

Howard Gardener’s book combines psychological theory with educational practices. Gardener examines why modern students are not meeting current standards. He mentions museums as an avenue of promoting students to take control of their own learning. His section of museums is the most application part of the work for our research. Most of the book is not relevant to our work, because we are not studying any classroom settings. We will use Gardener’s work to speak to the purpose of our project in the background section. (Page 3).


This paper looks at research derived primarily from academics working in the field of visitor studies. It outlines three approaches; the social, the cognitive, and the environmental perspective, which have been applied to studies of museum visitor behavior. The paper then presents the findings from an observational study of visitors to a city museum. These findings are recast in the light of the three approaches described, in order to offer an integrated framework of customer behavior which has implications for the management of the service encounter in museums. These approaches are critically evaluated throughout the paper and show the author’s vast knowledge on the subject area. The visitors experience is very important to museums success and it is very important to consider these different areas.

The methods used for this article can be seen as very effective in conveying the main point. The three areas explored in the article will also be explored in our paper as well. We can use the approaches listed in the
article, as possible models for our methodology. We will combine these methods with those from other sources, to conceptualize the best method for studying visitor needs and impact. (Pages 9, 10).

This article discusses the exhibit Ground Up: Building Big Ideas, Together, located at scienceworks. This exhibit is designed for 0-5 year olds, with the intention of getting children thinking and developing skills, with the intention of developing skills that are key in STEM problem solving. This article will be used to show the push that Scienceworks has for getting more visitors involved and engaged in STEM. (Page 5).

This article is about Beyond Perception: Seeing the Unseen, which is the exhibit that our project will focus on. This article discusses the six main areas of the exhibit, along with photographs. This article will be used in developing background for our proposal, along with the photographs for our presentation. (Page 6).

Jennings created this source as a slideshow for a class. It discusses the science behind recognizing emotion from facial expressions. In our project we will need to identify engagement from the facial expressions and body language of our subjects, so this information will be instrumental for us. However, the source discusses solely identifying emotion for toddlers and babies, and doesn’t dive into doing so for older subjects. It does however
mention that babies are more inclined to represent their true emotions with facial expressions than adults, as their brains are not yet fully developed. (Page 14).


This article describes the stereotypical crowd that keeps going to museums time and time again. It’s a selective crowd and many like this article believe that museums need to appeal to a more diverse audience or they will come irrelevant. There have been studies conducted on museums to see the demography of the museum. According to the author, most museum workers are people of color and only make up a small fraction of the actual museum audience. Many believe that people of ethnic descent will show their talent and then take over the museum industry. Museums need to embrace diversity soon or else everyone will stop going to them. The author calls attention to the emerging problem and wants to see a change from these museums. The limitations in this article can be seen in the author proposing all these ideas of change, but doesn’t propose a definite plan.

This article was useful to see the emerging problems museums will face in the future. This also was useful to compare this problem that museums are facing with our problem and compare the two. Diversity is an important part in today’s society and needs to be critically thought about when evaluating a museum’s direction. The author concluded that change needs to happen and that if museums don’t act soon, then museums will become a thing of the past. (Pages 1, 9).


Livingstone classified distinct types of learning based on venue. The study identified the specific types of learning that occur in different physical locations. Livingstone listed the four main types of learning: formal, informal, non-formal, and self-directed. The study lists museums as the primary venue for self-directed learning.

We can use Livingstone’s educational theory to guide our understanding of the effects of people’s behavior in the exhibit. Self-directed learning is one of two major goals of Beyond Perception. Livingstone’s work does not the practice of motivating students toward a particular field, which is the other major goal of the exhibit. (Pages 3, 4).


This article discusses the opening of the Beyond Perceptions exhibit at the Melbourne Museum. This article reveals that the exhibit was a $3.75 million project and was designed to get more teens interested in STEM. This exhibit was government-funded, and shows that the government is serious about getting more teens involved in STEM. The article also contains quotes and reactions from Lynley Marshall, the Chief of the Museums Victoria, and Jenny Mikakos, the Minister for Children and Families, giving praise for the new exhibit, saying that it hopefully will have an impact on teens in the future.

This article will be used for the background and introduction section of the paper to provide more insight into why the exhibit is important to the Melbourne Museum. The quotes will also provide additional insight into
the exhibit and its importance to the museum, as it shows what experts think of Beyond Perceptions. (Page 5).


Oliveira and his team piloted a Bluetooth visitor tracking study at ”The Mind” exhibit at the Melbourne Museum. Researchers placed beacons around the exhibit, and asked visitors to carry Android phones running custom software as they walked through the exhibit. Oliveira presented his findings, including visualization of the Bluetooth data to the Melbourne Museum during our project. (Page 13).


The article presented a modern method of visitor tracking visualization, and tested it in an actual art gallery. The article recommends using a series of LIDAR poles in exhibits, and using sensors on the poles to measure visitor movement and the distance between visitors. The article reviews the mathematics that describe how the LIDAR system works, as well as how to use to predict the path of future visitors. The group then compared their LIDAR system to traditional pen and paper tracking.

The major limitation of this article is that it reviews how to track visitors, but does not elaborate on what visitor tracking tells us. The group analyzed the LIDAR system to test how practical the automated visitor tracking is. The group also suggested the best way to display LIDAR data is with heat maps. Unlike traditional pen and paper tracking, heat maps do not display outliers in the data set. This article is of use to our team.
because it discusses the major implications of visitor tracking methods. The article also lists other resources that teach about other automated visitor tracking methods. We can use this article, and others like it, to help decide what is the best method of execution and visualisation for visitor tracking for our project. (Page 12).

Sanford, Camellia W. (2010). “Evaluating Family Interactions to Inform Exhibit Design: Comparing Three Different Learning Behaviors in a Museum Setting.” In: Visitor Studies 13.1. DOI: 10.1080/10645571003618782. Sanford investigates the possible connection between three frequently used indicators of museum engagement: time spent, exhibit interaction, and discussions. Sanford found that only using one indicator is not a sufficient measure of museum experience, and that all three need to be considered when evaluating an exhibit. The study is limited by its focus on families. We will be dealing with families, but also large school groups of children- who may behave differently when they are not around their parents. (Page 14).

Scienceworks About Us (2018). URL: http://museumsvictoria.com.au/scienceworks/about-us/. This website is the official Museums Victoria information page for the Scienceworks Museum. The information presented on this webpage has key information about the history, location and goals of the museum. The major limitation of the source is that it does not share any specific insights about the audience demographics of the organization. (Pages 4, 5).

This article discusses the Beyond Perceptions: Seeing the Unseen exhibit. This exhibit was made with 27 scientists and teens on the JBoard. The JBoard and group of scientist met on a monthly basis, collaborating on everything from the initial brainstorming to testing prototypes of the exhibit. The exhibit is supposed to be an immersive experience with the goal to get more teens interested in STEM. The museum also has another exhibit called Ground Up: Building Big Ideas, Together which is an exhibit for 0-5 year old’s to get them interested in STEM.

This article provides an outside perspective and thought on Beyond Perception exhibit. The information about this being an exhibit “By teens for teens” is useful, as that is the target demographic for this exhibit, and what we will be studying as a team in Australia. This article provides significant information on Beyond Perception, because it describes how the initial ideas of the exhibit were created. This information is critical for our background section, as descriptions of the exhibit are needed to describe the exhibit that we will be studying and observing. (Pages 2, 5, 6).

Shearer took us on a tour of Beyond Perception, guided with is own notes from the making of the exhibit. He shared his intentions for the space: for people to leave being interested in science rather than having learned a ton of facts and also for the space to be a home for social moments between people. He shared that his advisory panel preferred the idea of having goal oriented interactive attractions in Beyond Perception, but it was his decision to make them open-ended. (Page 6).

Strategic Plan (2017). Museums Victoria. URL:

This is the Strategic Plan for Museums Victoria for 2017-2025. This plan includes the Museum’s Mission Statement, Objectives, and plans for each individual museum. This will be used for background of the Museums Victoria. (Page 5).

Thorne, S. (2000). “Data analysis in qualitative research.” In: EBN Notebook 3. URL: https://ebn.bmj.com/content/ebnurs/3/3/68.full.pdf. This article goes into depth about several approaches to qualitative data analysis. It discusses various approaches to data analysis such as grounded theory, phenomenology, ethnography, and narrative analysis. It presents a table containing each method, gives an example of what question might be asked, and then shows what results could be harvested from that method. For example, the grounded theory method when applied to the question “how do women with breast cancer cope with changing body image?” results in a theory describing the basic social processes that women employ to cope with breast cancer and factors that account for variation in results.

These methods will be important for us to consider when we begin diving into the data that we collect. It’s important for us to tackle our data with a clear, logical method in mind such that we don’t waste time analyzing data in a manner that won’t give us the results that we’re looking for. (Page 15).


The Boston Museum of Science connected us with Senior Research and Evaluation Associate Katie Todd. She provided us with information on the topic of museum diversity. Katie’s email emphasized that the Boston Museum of Science focuses on the topic of diversity. The email she sent
provided us the information from the Boston Museum of Science on the meeting of museum professionals from across the country to discuss the coalescence of exhibition design strategies for different audiences. This source provided us a large number of comparable studies around the topic of diversity. Our group specifically looked at the study called the Science Behind Pixar. This study looked at the different audiences across all demographics and even some trials with children with disabilities. This source was valid for our paper because it is a similar study comparable to our own project. This project explores the topic of diversity and aided our methodology when conducting data collection. (Page 8).


Tröndle’s group quantified visitor behavior and experience, by studying the Swiss national project eMotion -mapping museum experience. The group conducted trials to study the effects of different spatial set ups on visitor behavior. They tracked visitors and recorded their behaviors. The team used position and time data of visitors, collected behavioural data, quantified visitors’ reactions, and experimented with placement of art inside of the exhibit. The team made conclusions about how the spatial designation of an exhibit affects the behaviour and impact on its visitors. The report claims that this should be a pilot study for a larger investigation into visitor reactions. Only 30 visitors were subjected to this study, a relatively small sample size. The authors also point out that this was not a controlled laboratory study, and that there might be external variables influencing their results. The paper directly addresses that this was a study of visitor attention, not of visitor impact.
Our team can use this article for its conclusions on visitor attention and its methods. The piece includes multiple graphs and detailed methods, which we can consider when developing the methods for our project at Museums Victoria. We are going to consider the limitations of this piece, because the authors directly listed ‘holes’ in their own methodology. We can use this article to develop our own visitor study and to avoid potential issues with our data. (Page 1).

Tucker, Mark, Jon Bricker, and Alexandria Huerta (2011). “An Approach to Measuring Impact and Effectiveness of Educational Science Exhibits.” In: Journal of Applied Communications 95.2. DOI: 10.4148/1051-0834.1172. This source focuses on the development and construction of museum exhibits. It gives a detailed explanation of the start-to-finish process that the exhibit fabrication professionals at Purdue University use to plan, prototype, and create their exhibits. It also discusses the methods through which they collect data for use in exhibit design. These methods include the meso-genetic method, which consists of keeping a detailed history of the changes made to the exhibit over time; the visitor observation method, which tracks visitors and records which exhibits they visit and how long they spend there; survey techniques; experimental design; and visitor interviews.

This source is important for several reasons. Firstly, it will give us an inside perspective on the planning and creation of an exhibit, which will allow us to give a more detailed and relevant recommendation for exhibit tailoring. Secondly, we will be employing some of the methods described for data collection. However, others we had not been exposed to and may end up being a vital part of our project. The detailed descriptions of these techniques could will be invaluable in our project. (Pages 11, 13).


Yalowitz discusses the idea of pen and paper visitor tracking in this article. Essentially, he outlines the importance of understanding how visitors respond to exhibits, and how that is integral to a museum’s survival and relevance. He also describes the methods in which museums typically carry out visitor tracking. Additionally, it describes ethics of visitor tracking and also talks a little bit about the analysis of the tracking data. (Page 11).
Appendix A  Mission Statement & Strategic Objectives

Sections that reference Appendix A: (2.2)

A.1  Mission Statement of Museums Victoria

- We create knowledge and experiences that help us make sense of the world
- We exchange stories about culture, history and science and fearlessly discuss the big questions of life
- We collect traces of time and place that allow us to connect the past, present and future
- We make captivating physical and virtual spaces that open minds and hearts

A.2  Strategic Objectives of Museums Victoria

1. Museums Victoria provides unmissable experiences for all audiences
2. Museums Victoria has the primary material collection that inspires and allows excellent enquiry into our region’s big contemporary and historical questions
3. Museums Victoria engages with, welcomes and celebrates all communities
4. Museums Victoria is a centre for technological and scientific expertise and fosters innovation to build economic value
5. Museums Victoria is a sustainable and thriving organisation
Appendix B  Survey Questions

Sections that reference Appendix B: (2.5.1, 3.2, 4.4)

1. Estimated Age Range?
2. Demographic of the Group?
3. Rank the Following on a Scale from 1-10 (10 being the best):
   (a) Educational Value of the Exhibit
   (b) Desire to Learn More About Science of the Exhibit
   (c) Amount of New Things You Learned from the Exhibit
   (d) How likely Are you to recommend this exhibit to someone?
4. Circle All That Apply: What age range do you think Beyond Perception is best suited for?
   • Infant
   • Toddler
   • Child
   • Teenager
   • Young Adult
   • Adult
   • Elder
5. Was it appropriate for your age range?
6. What was your favorite part of Beyond Perception?
7. What was your least favorite part of Beyond Perception?
8. How would you describe Beyond Perception to someone?
9. Who would you recommend this exhibit to? Why?
10. Why did you come to Scienceworks today?
Appendix C  Survey Script

Sections that reference Appendix C: (3.2, 3.4)

Hello! I am an intern working with Museums Victoria to study visitor interaction in Beyond Perception. Would you mind taking a survey to help our study? It should take less than 5 minutes.
Appendix D  Beacon Map

Sections that reference Appendix D: (3.4)
Appendix E  Visitor Observation Sign

Sections that reference Appendix E: (3.5)

Visitor Observations in Progress

*If you have any questions or concerns, please speak with a customer service officer.*
Appendix F  Visitor Tracking Matrix

Sections that reference Appendix F: (3.6, 4.3)
Appendix G  Summative Evaluation

Sections that reference Appendix G: (3.8)

Beyond Perception Summative Evaluation

Report No: 1134

SURVEY PERIOD: 18 July - 7 Aug 2018 | RESPONDENTS: 136 | METHOD: face to face survey

Summary:

- The vast majority of visitors had never heard of Beyond Perception before their visit and did not learn about it until walking into the exhibit itself (69.9%).
- 73% of visitors had never seen Beyond Perception before.
- 31% of visitors had been to Scienceworks in the past year, and 49% of visitors had not been in the last 3 years.
- 20% of visitors described the exhibit as “mentally stimulating or interesting.”
- 93.3% of visitors gave the exhibit a positive rating, while 52.6% said it was “very good.”
- 100% of surveyed visitors within the target age range (10-17 years) gave the exhibition a positive rating.
- Overall, visitors rated individual exhibitions within Beyond Perception very highly.
- Visitors within the target age range rated individual exhibitions within Beyond Perceptions very highly.
- Beyond Perception has a net advocacy score of +43.
- In general, visitors within the target age range responded that they were more interested in STEM after viewing Beyond Perception.
- Members of the target age range found Beyond Perception to be more enjoyable than the average visitor.
- 90% of visitors said that this exhibit would be suitable for 14-17-year-olds.
- 91% of visitors live in Australia.
- 15.2% of surveyed visitors fell within the target age range.

Recommendations for Future Improvements:

- A marketing campaign, focused on social media, should be designed to make visitors aware of Beyond Perception, as few visitors came to specifically see this exhibit.
- Creating a system of directions within the exhibit to explain how the space is intended to be used to visitors, as many visitors commented that they were confused by the lack of a clear path in the space.
- Adding labels in the exhibit to mark what each section is supposed to represent, as multiple visitors complained about the lack of labels to indicate precisely what they were learning about.
- Host events in the space geared toward an older audience because a portion of the visitors wanted to experience the space without children in it.
Awareness of Beyond Perception:

11% of visitors knew about Beyond Perception before they came to Scienceworks, compared to 54% from a similar study done on Ground Up. The discrepancy here is striking, as the vast majority of visitors to Beyond Perception were unaware that it even existed at all before arriving at the museum. Also, worth noting is how small the number of people who came specifically to see Beyond Perception is. Of the 11% who were even aware of it, only 2.2% of all visitors came specifically to see it.

The vast majority of visitors (69.9%) had never heard of the exhibit before exploring the museum. 88% of the people who had visited Scienceworks before had never heard of Beyond Perception either.

<table>
<thead>
<tr>
<th>Compared to Ground Up</th>
<th>Beyond Perception [n=133]</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Came especially to visit SW but knew about Beyond Perception before arrived</td>
<td>5.9%</td>
<td>21%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knew about Beyond Perception before arrived and came especially to see it</td>
<td>2.2%</td>
<td>13%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Came BOTH to visit SW and to see Beyond Perception</td>
<td>2.9%</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Came especially to visit SW and heard about Beyond Perception when first arrived</td>
<td>19.1%</td>
<td>18%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Came especially to visit SW and only came across Beyond Perception going through the museum</td>
<td>69.9%</td>
<td>28%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources of Awareness:

Very few visitors found out about Beyond Perception through social media or Museum news, however, a significant portion of people (20%) found out about Beyond Perception through family or friend. In general, people who had visited Scienceworks before had a higher percent of being informed of new exhibits via social media.

<table>
<thead>
<tr>
<th>How did you hear about Beyond Perception?</th>
<th>All visitors [n=15]</th>
<th>Visited SW before [n=12]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unchecked</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Facebook</td>
<td>6.7%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Instagram</td>
<td>6.7%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Twitter</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Friend or family</td>
<td>20%</td>
<td>16.7%</td>
</tr>
<tr>
<td>SW website</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Another website</td>
<td>6.7%</td>
<td>8.3%</td>
</tr>
<tr>
<td>MV enews</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Member enews</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Outdoor advertising</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>46.7%</td>
<td>50%</td>
</tr>
<tr>
<td>Can’t recall</td>
<td>13.3%</td>
<td>8.3%</td>
</tr>
</tbody>
</table>
Repeat Visitation:

The data here shows that most people either come to Scienceworks very frequently (within the last 12 months), or they come very infrequently. The middle times of 1-3 years between visits are less common than longer or shorter times. 49% of people had either not been to Scienceworks in the last 3 years or never been, and an additional 31% of people have been to Scienceworks within the last year. That leaves only 20% of people who had visited less recently than 1 year, but more recently than 3 years.

Describing Beyond Perception:

Below is the responses from visitors when asked how they would describe Beyond Perception. These results have been coded into general categories. Mentally stimulating / interesting was the most common response (20%).

<table>
<thead>
<tr>
<th>How visitors describe Beyond Perception [n=136]</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mentally Stimulating/ Interesting</td>
<td>27</td>
<td>20%</td>
</tr>
<tr>
<td>Generally Positive Comments (good/great/cool)</td>
<td>19</td>
<td>14%</td>
</tr>
<tr>
<td>Relaxing Atmosphere/Lighting</td>
<td>17</td>
<td>13%</td>
</tr>
<tr>
<td>Interactive</td>
<td>12</td>
<td>9%</td>
</tr>
<tr>
<td>Original/ Unique</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td>Child/Teen Friendly</td>
<td>12</td>
<td>9%</td>
</tr>
<tr>
<td>Artistic</td>
<td>4</td>
<td>3%</td>
</tr>
<tr>
<td>Overlap</td>
<td>34</td>
<td>25%</td>
</tr>
</tbody>
</table>

“Mind blowing”

“It’s about waves I would say it’s quite a tactile visual exhibition for lots of ages good for toddlers”

“It’s cool, it has some interactive things like misty stuff and has exhibits that glow. Even if you don't understand what’s going on, it's still aesthetically pleasing.”
“It was a unique exhibition that challenges what you normally expect.”

“An interesting insight into unseen and counter-intuitive concepts in our universe, with fun interactive exhibits.”

“It was a thrilling surprise, had no idea. Was expecting a boring display.”

“I felt like it was good to be in your own and there wasn’t a linear feel which was pretty good”

“Kids loved it. The information, while interactive, wasn’t in child speak.”

“Would like an adult only event there.”

“The exhibition was a really cool take on perceptions and explaining somewhat complex concepts such as galaxies”

Rating of Beyond Perception:

During the survey, visitors were asked to give an overall rating of Beyond Perception.

Beyond Perception rates very highly among visitors — with almost all (93.3%) giving a positive rating. Beyond Perception rates extremely highly with its target audience (10-17-year old’s)—100% rated the exhibition positively.

Ratings are consistently high across all demographics.

- 52.6% of a general audience rated Beyond Perception as “very good”
- 100% of the target audience rated the exhibition positively
- 55% of the target audience rated the exhibition as “very good”

“It was really good because it was almost like a ride, you felt like you were in another world and everything was different”

“Found it quite relaxing”

“Very cool and immersive”

“It was a thrilling surprise, had no idea. Was expecting a boring display.”
**Average Ratings of Elements of Beyond Perception:**

- Overall, a general audience rated the elements of Beyond Perception Highly.
- On a scale of 1-10, most of the average rankings were between 8.4-9.0 with standard deviations between 1.3 and 2.
- The ranking of the Amount of Information in Beyond Perception had a mean of 9.6, but a standard deviation of 11.
- Most of the elements of Beyond Perception were rated very highly, with 8 out of the 9 categories having mean scores of above 8.5.

**Target Audience Likes About Beyond Perception:**

- The target audience (10-17 year olds) rated the elements of Beyond Perception highly.
- On a scale of 1-10, most of the average rankings were between 8.1 and 9.4, with standard deviations between 0.75 and 2.4.
- The ranking for Amount of Information had a mean score of 12.9, with a standard deviation of 20.

Many of the elements of Beyond Perception were rated very highly, with average scores above 8.5. Both the general audience and the target audience rated the elements of Beyond Perception very highly. The target audience (10-17-year-old’s) rated the 5 out of the 9 elements higher than the general audience: Exhibit Design, Atmosphere, Visual Screens & Projections, Amount of Information, Interactive Elements, and Overall Experience.
Perceptions of Beyond Perception:

When asked to rate Beyond Perception on a scale from 0 being the leftmost word, 100 being the rightmost word, Beyond Perception was found to be:

- An exhibit that is different to other exhibits at Scienceworks
- Immersive
- Relaxed
- Enjoyed with others

Comparing the general response, the target audience finds the overall exhibit to be more enjoyable than all visitors.

Q 8-Q 14. Where do you feel Beyond Perception sits on the following scale? [n= 133], [target n= 20]

<table>
<thead>
<tr>
<th>Where do you feel Beyond Perception sits on the following scale?</th>
<th>Target Audience</th>
<th>All Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same as Other Exhibitions at SW</td>
<td>70.7 71.8</td>
<td></td>
</tr>
<tr>
<td>Immersive</td>
<td>26 23.2</td>
<td></td>
</tr>
<tr>
<td>Fast Paced</td>
<td>73.25 79.55</td>
<td></td>
</tr>
<tr>
<td>To be Enjoyed with Others</td>
<td>39.79 37.3</td>
<td></td>
</tr>
<tr>
<td>Intriguing</td>
<td>21.38 14.55</td>
<td></td>
</tr>
<tr>
<td>Based Around the Science</td>
<td>50.5 60</td>
<td></td>
</tr>
<tr>
<td>Enjoyable</td>
<td>18.21 10.6</td>
<td></td>
</tr>
</tbody>
</table>

Beyond Perception is seen as an exhibit that is “Different to Other Exhibitions at Scienceworks”. Both the target audience and the general population see Beyond Perception as a “Immersive, Relaxed, and Intriguing” exhibit. Beyond Perception is an exhibit “To be Enjoyed with Others”. Beyond Perception is an exhibit that is a combination “Based around the Science” and “Based around the experience”. Overall, Beyond Perception is an “Enjoyable” exhibit, with the target audience saying that beyond perception is more “Enjoyable”.

83
Advocacy:

Beyond Perception has a Net advocacy Score of +43.

<table>
<thead>
<tr>
<th>Not at all likely</th>
<th>Extremely likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>MEAN</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>17</td>
<td>32</td>
</tr>
<tr>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>8.5</td>
<td></td>
</tr>
</tbody>
</table>

Detractor: 5%  Passive: 20%  Advocate: 75%

Net Advocacy Score = +43

Critical Feedback

Visitors most often gave no feedback, however those that did give feedback frequently wanted more information in the exhibit. This is a theme that emerges frequently in this study. Visitors commonly, when given the opportunity, commented on the clarity (or lack thereof) of the information presented. Some other common ideas in feedback were suitability to children, interactivity, and crowdedness.

<table>
<thead>
<tr>
<th>Type of Feedback</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>31%</td>
</tr>
<tr>
<td>More Information</td>
<td>26%</td>
</tr>
<tr>
<td>General criticism</td>
<td>24%</td>
</tr>
<tr>
<td>Make more suitable towards children</td>
<td>13%</td>
</tr>
<tr>
<td>More Interactives</td>
<td>11%</td>
</tr>
<tr>
<td>Crowded</td>
<td>4%</td>
</tr>
</tbody>
</table>
Impact from Beyond Perception

Overall, respondents within the target age range found Beyond Perception to be an interesting and stimulating place. 88.1% of respondents reported being intrigued before even walking into the exhibit, and 75% agreed that the exhibit increased their interest in careers in the fields of science and technology. Furthermore, 85% of visitors reported feeling connected with the science that is being displayed within Beyond Perception.

Respondents in the target age range agreed that Beyond Perception made them curious to find out more, enjoy what they learned, remember previous knowledge, and think about worldly phenomenon. 95% of the respondents in the target age range agreed that Beyond Perception made them curious to learn more. 100% of respondents in the target age range agreed that they enjoyed what they learned in Beyond Perception. 100% of the respondents in the target age range agreed that Beyond Perception made them think about things going on in the world around them.
Reaching Target Audience:

When asked if the exhibit was suitable for a given age range, most people, (90%), said that this exhibit would be suitable for 14-17 432-year-old’s, which is in the target audience. For the age range of 10-17 years old, the majority of respondents said that the exhibit would be suitable for those ages.

Profile of Visitors:

Of the 132 people that were surveyed, there was 91% living in Australia making up the majority of the data. Of this 91%, the data collected for recurring visitors was also exceptionally high of around 73%. The trend of residents living in Australia and recurring visitors goes together proportionally.

- Of the 132 people that were surveyed, there was 91% living in Australia making up the majority of the data.
73% of the visitors were first time visitors to Beyond Perception, while 27% were returning visitors.

Of the survey population, only 15.2% surveyed were in the target audience of Beyond Perception, between the age of 10 and 17.
Group Information:

Of the ten groups presented below the amount in each group was greatest in group zero and group 1. The earlier the group the larger the amount is in that said group. After a certain number of groups there should be a cut-off time to be more efficient in collecting data. Out of a 132 there was only 15.2% in the target age of 10-17 years. This provided a lower amount of data, but in the group data the target age data doubled to 30.9% giving more quantitative values for the study.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number in Group</th>
<th>% in Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>95</td>
<td>69.90%</td>
</tr>
<tr>
<td>1</td>
<td>21</td>
<td>15.40%</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>8.10%</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>2.20%</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0.70%</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0.70%</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>0.70%</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>0.70%</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>0.70%</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>1.50%</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>0.70%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respondent in target age 10-17yrs</th>
<th>Percent</th>
<th>Any in Group 10-17</th>
<th>% in Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>15.20%</td>
<td>42</td>
<td>30.9% YES</td>
</tr>
<tr>
<td>112</td>
<td>84.80%</td>
<td>94</td>
<td>69.10% NO</td>
</tr>
</tbody>
</table>
Appendix H  Bluetooth .txt File

Sections that reference Appendix H: (5.3.1)

{"beaconCoordinates":[15.0,3.0],"beaconMacAddress":"[D9:0D:A4:13:27:80]","beaconMajor":10720,"beaconMinor":12037,"beaconUUID":"b9407f30-f5f8-466e-affe-2556b57fe6d","distanceToBeacon":3.157662481609009,"participantId":"SW005","timestamp":1543361704067}
{"beaconCoordinates":[],"beaconMacAddress":"[DD:FC:ED:83:42:79]","beaconMajor":7135,"beaconMinor":18511,"beaconUUID":"b9407f30-f5f8-466e-affe-2556b57fe6d","distanceToBeacon":4.83597393371257,"participantId":"SW005","timestamp":1543361705105}
{"beaconCoordinates":[],”beaconMacAddress”:”[DD:FC:ED:83:42:79]”,"beaconMajor":7135,"beaconMinor":18511,”beaconUUID”:”b9407f30-f5f8-466e-affe-2556b57fe6d”,
"distanceToBeacon":4.83597393371257,"participantId":"SW005","timestamp":1543361706146}
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{"beaconCoordinates":[31.0,29.0],”beaconMacAddress”:”[DF:D0:EA:71:6A:F5]”,
"beaconMajor":7134,"beaconMinor":18510,"beaconUUID":
"b9407f30-f5f8-466e-affe-2556b57fe6d","distanceToBeacon":4.18956100382855,“participantId”:”SW005”,“timestamp”:1543361708226} {"beaconCoordinates": [31.0,29.0],"beaconMacAddress": "[DF:D0:EA:71:6A:F5]", "beaconMajor": 7134, "beaconMinor": 18510, "beaconUUID": "b9407f30-f5f8-466e-affe-2556b57fe6d", "distanceToBeacon": 4.18956100382855, "participantId": "SW005", "timestamp": 1543361709269} {"beaconCoordinates": [31.0,29.0],"beaconMacAddress": "[DF:D0:EA:71:6A:F5]", "beaconMajor": 7134, "beaconMinor": 18510, "beaconUUID": "b9407f30-f5f8-466e-affe-2556b57fe6d", "distanceToBeacon": 4.18956100382855, "participantId": "SW005", "timestamp": 1543361710326} {"beaconCoordinates": [31.0,29.0],"beaconMacAddress": "[DF:D0:EA:71:6A:F5]", "beaconMajor": 7134, "beaconMinor": 18510, "beaconUUID": "b9407f30-f5f8-466e-affe-2556b57fe6d", "distanceToBeacon": 4.18956100382855, "participantId": "SW005", "timestamp": 1543361711348} {"beaconCoordinates": [31.0,29.0],"beaconMacAddress": "[DF:D0:EA:71:6A:F5]", "beaconMajor": 7134, "beaconMinor": 18510, "beaconUUID": "b9407f30-f5f8-466e-affe-2556b57fe6d", "distanceToBeacon": 4.18956100382855, "participantId": "SW005", "timestamp": 1543361712389} {"beaconCoordinates": [31.0,29.0],"beaconMacAddress": "[DF:D0:EA:71:6A:F5]", "beaconMajor": 7134, "beaconMinor": 18510, "beaconUUID": "b9407f30-f5f8-466e-affe-2556b57fe6d", "distanceToBeacon": 4.18956100382855, "participantId": "SW005", "timestamp": 1543361713428} {"beaconCoordinates": [31.0,29.0],"beaconMacAddress": "[DF:D0:EA:71:6A:F5]", "beaconMajor": 7134, "beaconMinor": 18510, "beaconUUID": "b9407f30-f5f8-466e-affe-2556b57fe6d", "distanceToBeacon": 4.18956100382855, "participantId": "SW005", "timestamp": 1543361714500} {"beaconCoordinates":...
Appendix I  Bluetooth Guide

Estimote Beacon Tracking Instructions

Using the Estimote App to set up the Beacons

1) Download the Estimote app to your phone and launch the application

![Estimote App](image1)

2) Tap the yellow configuration button

![Configuration Button](image2)

3) Login with the account associated with the beacons.

![Login](image3)
4) The beacons that are in range will appear on the screen after a few seconds.
5) Touch the list button on the bottom to view a list of all the beacons

6) Take one beacon and walk away from the group of beacons will isolate it, and will appear as the closest device.
7) Tap on the desired beacon to edit the information.

8) In this menu, you can change the name and view information about the beacon. If there is a software update, click that to update the beacon, as there are issues with beacon communication if the beacons are on different versions of the software.
9) Click on the broadcasting tap, and click iBeacon

10) The transmit power (Tx) will allow you to change the range the beacon broadcasts. Use the slider to adjust the distance for each exhibit. The distance may need to be changed after install, and this is where it can be adjusted. The beacons have a range of ~1 m to ~200 m.
Beacon Placement in the Exhibit

Make sure that the beacons are placed in the exhibit so they are out of sight from visitors. Thin walls will not obstruct the transmission of the Bluetooth signal. Be aware that some exhibits have technology that will interfere with the Bluetooth signals, and may result in data that not useable.

Using the McCoy App

1) Unlock one of the Android Phones, and go to the home screen. Swipe down from the top to access the control panel. Make sure that Bluetooth is turned on and that Wi-fi is turned off. This will ensure the app does not crash during operation.
2) Go back to the home screen and Locate the McCoy App.

3) Open the McCoy app.
4) To begin a test, enter a unique ID into the box. This is what the file will be named when the data needs to be retrieved.

5) Hit start. You will see the beacon that the phone is connected to on the screen.
6) If you are giving the phone to a guest, swipe down from the top to enable touch lock, this will lock touch inputs on the screen. Make sure the guest does not shut off the phone, as no data will be collected if the phone is off.
7) To stop the collection of data, hold the blue dot on the right side of the phone. When you see all of the applications open, press the x on the McCoy Window to close the app. This will stop the collection of data.
8) To access the data for the track, go to the home screen and open the file explorer.
9) To access the data from the track click on Phone Storage-> Download-> and then the name of the track that you are looking for.

10) If the track was successful, you will see something similar to this being displayed.
Appendix J  Parser

Sections that reference Appendix J: (3.4)

# David Larson, Michael Pierce, Austin Buck, and Katherine Gomes
# Museums Victoria
# Beyond Perception Visitor Study

import sys

dict = {
    46300: "Turbulent Encounters",
    59270: "Ramp Entrance",
    54646: "Cacophony",
    7134: "Cosmic Event 1",
    7135: "Cosmic Event 2",
    55538: "Waves at Work",
    47010: "Energetic Vibrations",
    44590: "Studio",
    10720: "Stair Entrance",
    14606: "Turret 1",
    61228: "Turret 2",
    9008: "Energetic Vibrations"
}

if len(sys.argv) <= 1:
    print("Command format: $python3 parser.py <sample.txt>")
    quit()

try:
    file = open(sys.argv[1]).readlines()
except FileNotFoundError:
    try:
        file = open("Tracking Files/" + sys.argv[1]).readlines()
    except FileNotFoundError:
        print("Enter a valid file name.")
        quit()
"Parsing ", sys.argv[1])

lines = str(file).split("",")
uids = []
for line in lines:
    if line.__contains__("beaconMajor"): 
        uid = int(line.split(":")[1])
        if uid not in uids: uids.append(uid)

badUids = []
for uid in uids:
    try:
        print(dict[uid])
    except KeyError:
        badUids.append(uid)
    print(uid)

print("Bad UIDS: ", badUids)