

Optimizing Educational Experiences in Museum Spaces

An Interactive Qualifying Project Report submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science Submitted on December 14th, 2015

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Abstract

Scienceworks, part of Museum Victoria, in Melbourne, Australia, offers interactive learning experiences oriented toward science and technology to children of all ages. Our team tracked visitors through all of Scienceworks to record their interactions with exhibits and with the space around the exhibits, then augmented those observations with surveys of visitors' opinions of their experiences. This whole of site visitor tracking study enabled an assessment of visitor behavior and an evaluation of current exhibit usage. Scienceworks will be able to use the information presented in this report to improve its exhibit design for the future.

Acknowledgements

We would like to recognize several individuals who supported our team for the duration of our project. Their assistance was vital to success of this project.

First, we would like to thank the administrators of Museum Victoria, and more specifically, Scienceworks for making this project available to Worcester Polytechnic Institute. In particular, we would like to thank our sponsor, Carolyn Meehan, Manager, Audience Insights for Museum Victoria, and Nurin Veis, Manager of Scienceworks, for their guidance, input and support.

Additionally, we would like to thank the staff at both Scienceworks and Melbourne Museum for their support during our stay. They allowed us to use whatever space we needed and provided assistance with understanding how the larger museum organization functioned. For this we are very grateful.

Lastly, we would like to recognize all of the people affiliated with Worcester Polytechnic Institute who played a major role in the completion of this project. Professors Dave and Joan Szkutak, as well as Professor Paul Davis, all contributed valuable guidance during the course of completing this project. Additionally, we would like to thank Allison Templar, Local Coordinator, and Professor Holly Ault, Melbourne Project Center Director, for providing us with the opportunity to complete this project.

Executive Summary

Scienceworks of Museum Victoria, located in Melbourne, Australia, is considered to be among world leaders in interactive exhibit design. The exhibits at Scienceworks have successfully entertained the museum's daily visitors over the years, but the time has come to establish a benchmark and begin exploring the future of Scienceworks. Visitor tracking studies have been known to reveal a plethora of useful information at Museum Victoria's other locations, and provided a good basis for the study to follow in this report. The purpose of this study was to observe children ages three to twelve in Scienceworks of Museum Victoria and answer the following research questions:

- “How are visitors currently using the exhibits at Scienceworks?”
- “How can the exhibits be altered to deliver a more engaging experience?”

To address these questions, we developed four objectives to guide our work. Care was taken to align our objectives with Museum Victoria's mission to provide the most engaging and educational experience possible to their visitors.

1. Self assess a baseline for visitor timing and interactivity at exhibits using the developed tracking instrument and categorize exhibits based on central themes.
2. Obtain visitor timing data across all exhibits, including holding time, transit time, and comparison with estimated designed timing data.
3. Track visitor position and behavioral indicators of learning at each exhibit to determine relative attracting power and level of engagement.
4. Benchmark the current interactivity of museum spaces and engagement level by numerical analysis of tracking data.

These objectives were accomplished through a number of established social science methods, combined with numerous analysis techniques. Statistical analysis was used to validate our implementation of the tracking methods. At various stages of completion, the study was presented to administrators and staff from Museum Victoria venues to ensure that our tracking and analysis methods were valid.

In addition to making conjectures about current exhibits and recommendations for future exhibit designs, the team explored the differences between traditional display exhibits and more interactive exhibits. A cross-section of all exhibit types was evaluated in depth to understand these differences. The cross-section consisted of one exhibit from each of the museum's three main exhibitions fitting each type: static display, interactive, and a hybrid of the two, totaling nine exhibits. An estimated “design time” was determined for each of these exhibits by each member of the team, who fully read all placards and used all interactive elements until the meaning of the exhibit was understood. The average of these times were used to estimate visitor engagement at exhibits.

The same set of nine exhibits was used to survey visitors exiting the museum to gain feedback regarding the favorability of each exhibit type. Children and their parents were asked which of the nine were their favorite, and which they thought was most educational.

Visitor Tracking and Gauging Learning Opportunities

The purpose of this project was to perform a whole site visitor tracking study. A previous report written by students from Worcester Polytechnic Institute explored the possibility of conducting visitor tracking by electronic means with Museum Victoria, but it was decided because of budgetary constraints that this study would be completed with a tracking team recording their observations and the position of visitors using “paper-and-pen” tracking.

The tracking team consisted of two members: one recording the times that visitors spent at various parts of the museum and exhibits, one recording visitor positions on paper, and both recording instances of behavioral indicators of learning. These indicators encompassed actions like pushing buttons, using touch screens, and conversing with other visitors. The interactions were worth points depending on the level of engagement and commitment required by the visitors. These point multipliers were applied to the total number of times the interaction occurred to create an engagement score for each of the twenty-one visitors tracked. The engagement score represented the level of interaction a visitor had in the museum.

Data Analysis and Findings

The hand drawn tracks, interactions, and timetables were converted into a digital format to aid in analysis. The digitized tracks were overlaid so they could be viewed together to assess visitor traffic. The tracking data was also used to generate heat maps, one of which is shown below, depicting the areas of highest congestion. Heat maps were also created using the number of interactions that occurred at each exhibit, showing hotspots wherever exhibit interactions was the highest.

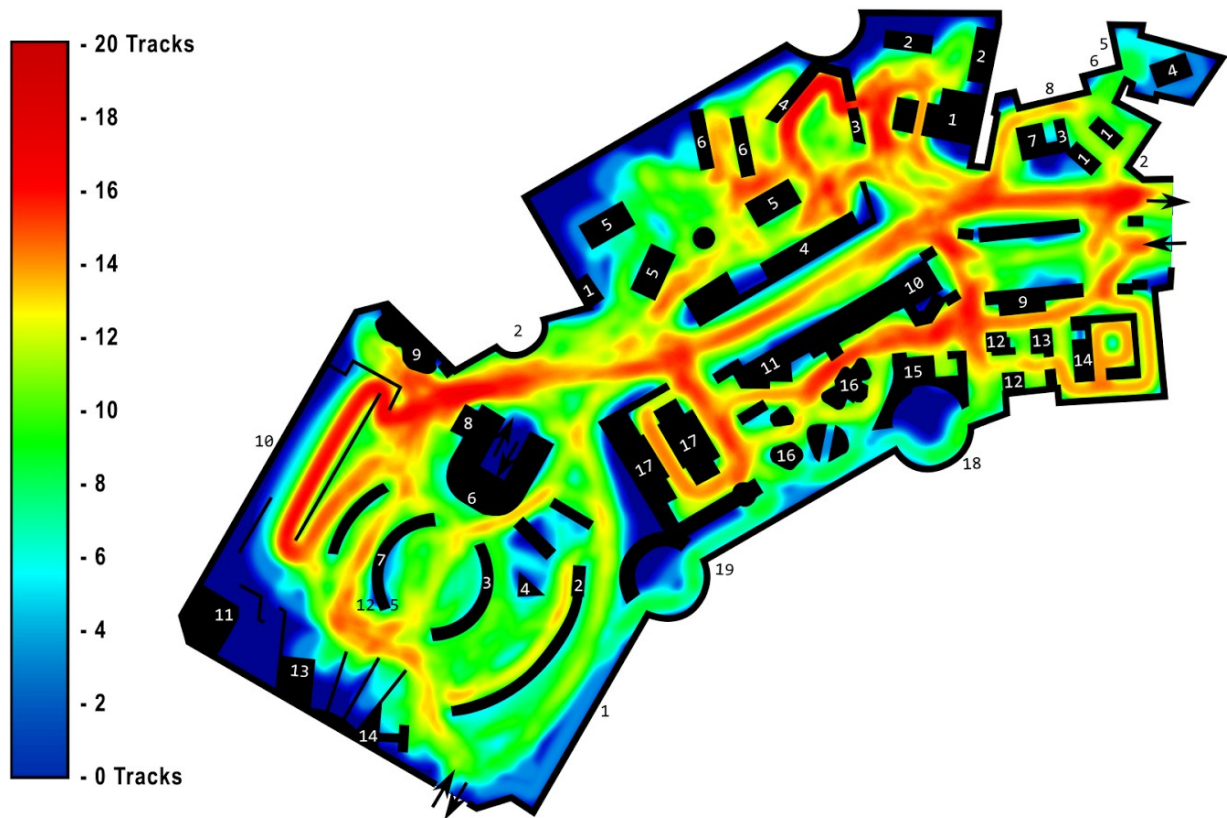


Figure 1: Tracking Heat Map First Floor

The engagement scores fit a normal distribution as shown in Figure 2 below. Scores ranged from the twenties, up to the nineties with the average being in the forties. The distribution skews slightly higher due to the four weekend tracks, which averaged an engagement score of 71.2 compared to the weekday average of 44.8. Due to this discrepancy, conducting more weekend tracks would be beneficial as mentioned in the recommendations at the end of this document.

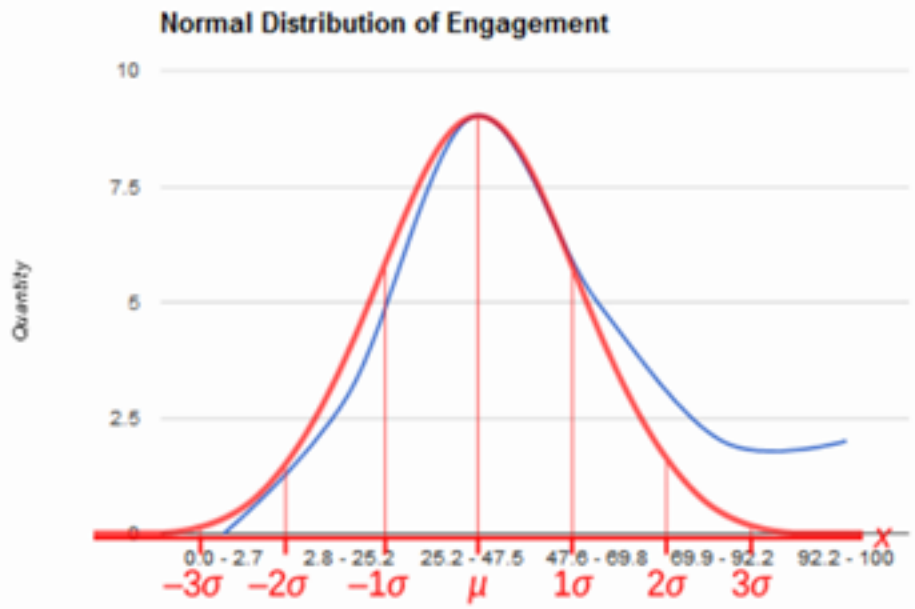


Figure 2: Normal Distribution of Engagement Scores

Analysis of the engagement scores across the nine representative exhibits discussed above lead us to conclude that interactive exhibits hold the attention of visitors longer, are more favored by children and parents, and garner a higher level of engagement from the target age group. The figure below shows that interactive exhibits in each of the three exhibitions have a higher percentage of interactions completed than the static display and hybrid type exhibits.

Interactivity Types vs. Utilization

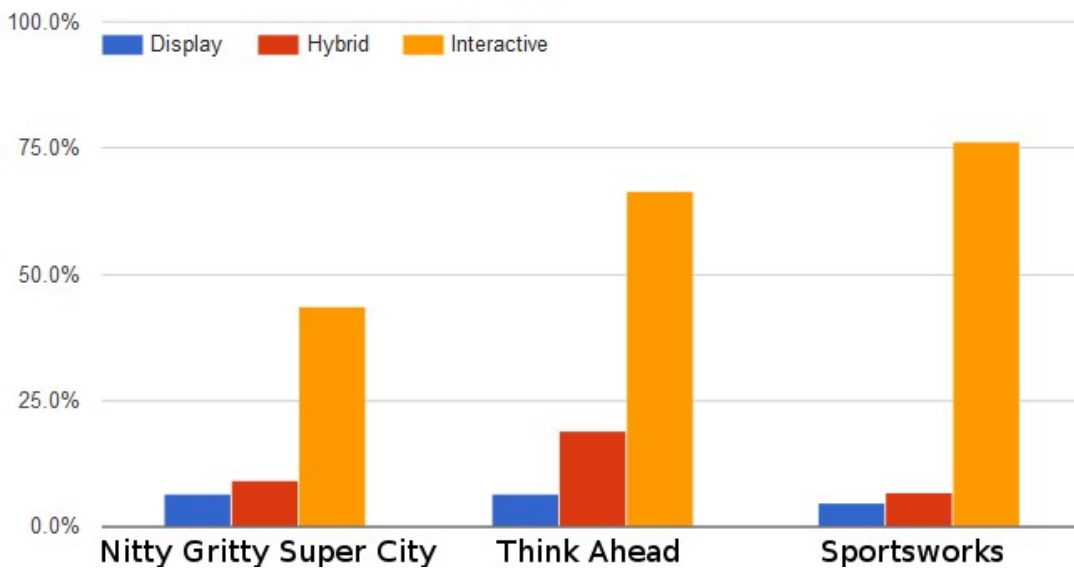


Figure 3: Utilization Averages by Exhibit Type

Figure 4 below shows how positively or negatively survey respondents reacted to each type of exhibit. Interactive exhibits received the most positive survey responses while display exhibits received the most negative responses.

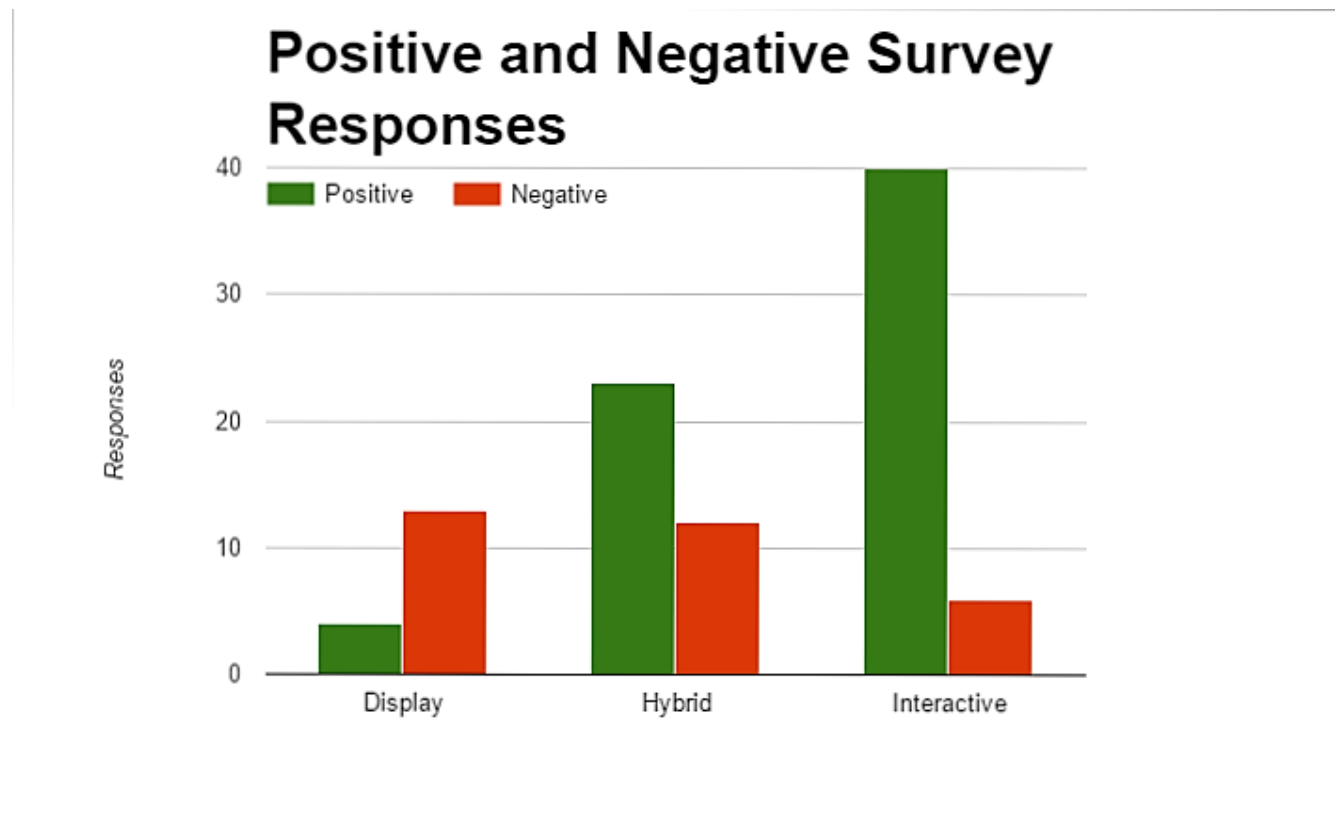


Figure 4: Positive and Negative Survey Feedback by Exhibit Type

Recommendations for Future Exhibit Designs

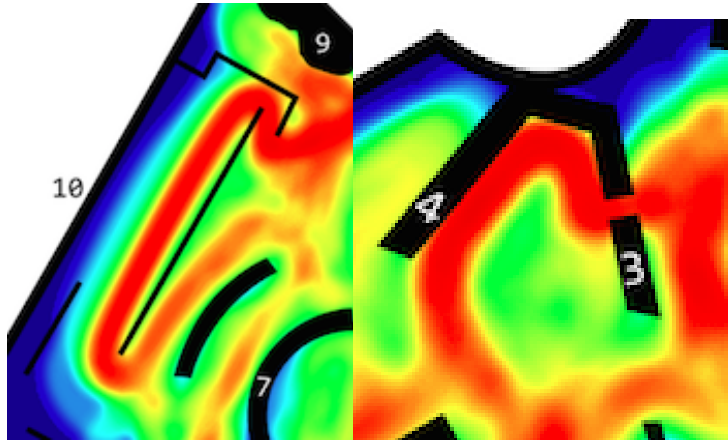
Recommendation 1: Consider including more interactive elements in exhibits, since interactive elements are preferred by visiting families.

Fully interactive exhibits are preferred over the traditional display-type. As stated above, the interactive-type exhibits garner a better response from visitors, as well as increased holding power. Building more interactive exhibits in the future at Scienceworks should yield increased audience participation and visitor satisfaction.

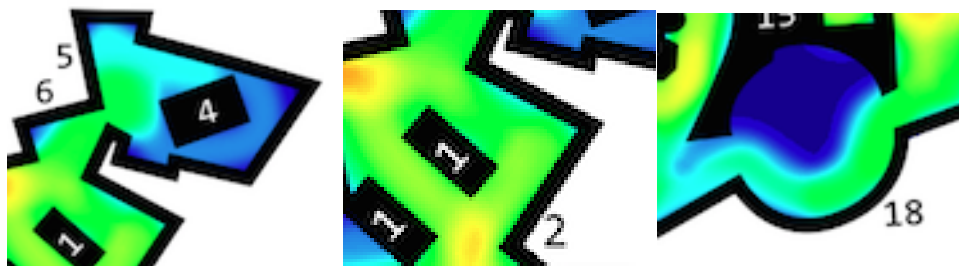
Recommendation 2: Attract more visitors to unexplored areas by: 1) improving signage or highlighted maps 2) making announcements about exhibits in these areas and 3) including interactive events in unexplored areas.

Certain areas of Scienceworks tend to be overlooked. Referring to Figure 1 (pictured above) showing the levels of visitor traffic, the tracking team determined that there are some exhibits in

Scienceworks that are rarely explored by visitors. These unexplored areas are represented in dark and light blue in Figure 1. Areas of high visitation can be seen in greater detail in Figure 5 while areas of less visitation can be seen in detail in Figure 6.



Race (Between 9 & 10) Alice Room (Between 3 and 4)
Figure 5: Examples of Highly Explored Areas



Future Visions (#4) Money Display (#2) Biotechnology Room (Rotunda (#18))
Figure 6: Examples of Less Explored Areas of Think Ahead

Recommendation 3: Provide more explicit instructions readily available for visitors to read before starting an activity, as some exhibits are not being used as intended.

A few exhibits are not being used in the ways intended by Scienceworks. There are a number of exhibits that can be used more effectively, and adding more signage or slightly modifying exhibit mechanics can aid this. In the exhibit involving the race against Cathy Freeman, a visitor presses a button to start the race sequence. The start sequence contains a delay, which causes children to leave early. More explicit instruction could notify visitors when to start running. Another example where more signage would benefit is the Excavator, where visitors can pick up balls in a ball pit. To start this exhibit you have to press a button to start the hydraulic pump. This button is off to the side and not readily visible. If there were instructions directing visitors to the button, then this exhibit could be used more effectively.

Recommendation 4: Daily environmental factors such as day of the week and number of visiting school groups should be taken into account in future tracking studies.

Visitor behavior is influenced by daily environmental circumstances. Some correlations were found between age, gender, day of week, duration of track, and engagement scores. Age had no impact on engagement scores, while females, and visitors on the weekends had higher engagement scores. Tracks were typically a half hour longer on the weekend, and fewer school groups made for less congested exhibits, possibly leading to this increase in engagement score over the weekends.

Recommendation 5: Consider completing more weekend whole of site visitor tracks as the majority of the completed tracks were on weekdays.

There was significant difference between weekend and weekday data, with weekend tracks having higher engagement scores and longer visits. We tracked older children on the weekend because the older age group was underrepresented in our data due to there being less older children present during the weekday tracking period. Seventeen of our twenty-one tracks were completed on weekdays, meaning that the weekend data is also underrepresented.

Summary

The goal of this project was to observe visitors in Scienceworks of Museum Victoria, evaluate how they were currently using the exhibits, and provide recommendations on how the exhibits can be more meaningful and engaging. Through our background research and experience with visitor tracking at Scienceworks, our team was able to successfully evaluate the current usage of various exhibits and determine possible improvements. We also provided Scienceworks with recommendations regarding improvements to their exhibit design and future tracking studies. Additionally, our team has supplied Scienceworks with an assessment of visitor behavior and an evaluation of current exhibit usage. Scienceworks will be able to use the information presented in this report to improve their exhibit design for the future.

Authorship

Jack Blanchard, Nicholas Cyganski, Michelle Henderson and Zachary Peters all contributed to the research and writing of this report. The following is a breakdown of their individual contributions to the report.

Jack Blanchard contributed to this report by writing portions of Chapters 2, 3, 4 and 5 in conjunction with other members of the group. Mr. Blanchard also edited almost every single part of the report. He also computed all engagement scores found within this report. Mr. Blanchard was responsible for compiling the final report.

Nicholas Cyganski contributed to this report by writing the Abstract, Executive Summary, and portions of Chapters 1, 2, 3, and 4. Mr. Cyganski edited every chapter except one. He also created many of the graphics that appear in this report.

Michelle Henderson contributed to this report by writing portions Chapters 4 and 5 as well as writing the Interaction Descriptions in Appendix B. Ms. Henderson also wrote the Tracking Guide in Appendix C and the Exhibit Commentary in Appendix E. She also edited major portions of this report. Finally, Ms. Henderson spent over sixty hours tracking visitors and provided all of the hand drawn maps, which were the basis for the graphics seen in Appendix F. She was responsible for compiling the final report.

Zachary Peters contributed to this report by writing the Acknowledgements and portions of Chapters 1 and 4. Mr. Peters also wrote the Tracking Guide in Appendix C and the Exhibit Commentary in Appendix E. He also edited many portions of the report, most specifically Chapter 4. Finally, Mr. Peters spent over sixty hours tracking and provided all of the timing data for analysis seen in Appendix F.

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Acknowledgements.....	Zachary (ed. All)
Executive Summary.....	Nicholas (ed. All)
Chapter 1 Introduction.....	Nicholas & Zachary (ed. Jack, Nicholas & Michelle)
Chapter 2 Background.....	Jack & Nicholas (ed. Jack, Nicholas & Zachary)
Chapter 3 Methodology.....	Jack & Nicholas (ed. All)
Chapter 4 Data and Analysis.....	All (ed. Jack, Michelle, & Zachary)
Chapter 5 Recommendations & Conclusions.....	Jack & Michelle (ed. Jack, Nicholas, & Michelle)
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Appendix B.....	Michelle (ed. Jack & Nicholas)
Appendix C.....	Michelle & Zachary (ed. Jack & Nicholas)
Appendix D.....	Group
Appendix E.....	Michelle & Zachary (ed. Nicholas)
Appendix F.....	Michelle & Zachary
Appendix G.....	Group

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1. Introduction

With smartphones and tablets prevalent within society, the attention spans of humans have decreased, as they become more obsessed and overwhelmed with content to check. Since the year 2000, the average attention span has fallen to just eight seconds (Hooton, 2015). With so much information online and available to users, how are museums, with their static displays, able to captivate the attention of their visitors? The Smithsonian Institute in Washington, D.C. suggests that its exhibit designers consider questions like, “Can you convey what you want if the visitor’s attention span is only 1-3 minutes?” or “Can the activity be accomplished quickly?” (Pekarik 2002). Outside research suggests that even extreme brevity is not enough to hold visitors’ attention. Since the rapid expansion of natural history museums in the 1960s, museum staffs have been studying the flow of visitors and their reactions towards exhibits, with an effort to combat the shortening attention span (Black, 2005). There have been several groups dedicated to observing visitors. The first was “The First Annual Visitor Studies Conference ” in 1988 (Black, 2005), and most recently, the MARVEL project (Museums Actively Researching Visitor Experiences and Learning), which focuses on visitor traffic in Australia (Griffin, 2005).

Although modern electronic technology allows researchers to track the movement of visitors with great accuracy, it does not allow researchers to observe visitor behavior. Quite often the museum managers are only concerned with the efficiency with which the visitors traverse the locale; however, the interactions visitors have with exhibits are also important to understand. One museum that is interested in learning how their visitors interact with the exhibits around them is Scienceworks, a science and technology based museum in Melbourne, Australia. Scienceworks is part of Museum Victoria that has several venues located across Melbourne. Our project was to help Scienceworks understand how their visitors interact with museum spaces so that they can better update their exhibition halls for future use. The museum wanted us to track visitors’ positions in addition to determining their engagement with the exhibits. Engagement refers to a visitor’s level of interaction with an exhibit. To supplement this assessment, we conducted observational research as well as surveys, asking visitors their opinions of the various exhibits. The data that we collected will help Museum Victoria and Scienceworks understand how to better engage their visitors, while also improving current exhibits to make sure the whole museum is being explored.

In the future, Scienceworks hopes to utilize the collected information as a guide for development, specifically to measure the success of their “Scienceworks of the Future” project.

2. Background

2.1 Museum Goals in Science Education

Globally, attention spans have been shortening for decades. Some attribute this to our overuse of mobile technology in our daily lives. The attention span of the average human has fallen from an average of twelve seconds in the year 2000 to just eight seconds in 2015 (Borrelli, 2015). Textbooks and classroom learning are becoming less effective by the year, due to the perceived dullness of the material (Gilman, 1916); however, museums have remained appealing (Dixon, 2011) because of their ability to captivate audiences with the physical world around them. With shortening attention spans, the role of museums in society becomes more about educating the masses than preserving items of antiquity, for museums can be seen as the alternative to classroom learning (Rader & Cain, 2014). As physics legend Frank Oppenheimer had been known to say, “No one ever flunked a museum” (Rader & Cain, 2014). Oppenheimer went on to found the Exploratorium in San Francisco Bay, the museum that pioneered the implementation of interactive exhibits (“Recent Institutional Awards”, 2015). Having a whole museum to explore can replace a classroom for those who cannot focus in a traditional setting with a lecturer and a textbook.

Many organizations across the world dedicate their time and money to interesting children in science, technology, engineering, and math (STEM). Ioannis Miaoulis, President and Director of the Museum of Science, Boston, has said that museums are key to STEM success (Miaoulis, 2011). As a STEM learner of any age will attest, the key to appreciating material is being engaged with it from the start (Allen, 2015). For younger audiences, this engagement can take the form of interactive museum exhibits and displays and has proven to teach a wide variety of material successfully at an early age (Miaoulis, 2011). The way people learn and interact is changing at an increasingly rapid pace thanks to the very technological pipelines that are shortening attention spans; thus, museums are constantly working to compensate for the continuous change.

2.2 A Global Shift Towards Interactivity

At the beginning of the twentieth century, a shift towards interactive exhibit design opened up a new avenue of research that was previously unexplored, since interactive exhibits were not formally an accepted part of museum research culture. In 1916 Benjamin Gilman coined the term “museum fatigue” in a research article for *The Scientific Monthly* describing a decrease both in the number of exhibits seen by individual visitors and in the amount of time spent at each (Gilman, 1916). This study was completed in 1916, long before interactive exhibits became popular. Gilman stated at the time that “radical changes in our methods of exhibition are imperative” because much of what museums had was “preserved, not shown” (Gilman, 1916, pg. 62). Museums that introduced exhibits involving physical interaction almost immediately saw a large increase in the number of visitors (Caulton, 1998).

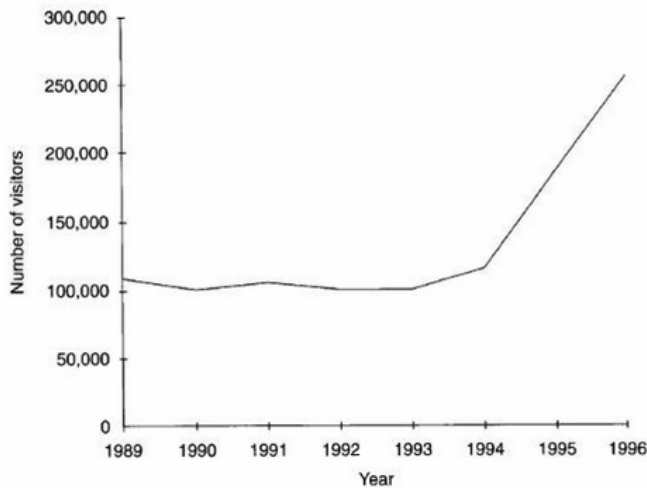


Figure 7: Number of Visitors the Museum Technique Saw Each Year from 1989 to 1996.

Figure 7 shows the number of visitors to Technique from 1989 to 1996. Technique, a science center in the United Kingdom that incorporates a high number of interactive exhibits into its museum design, saw over 100,000 people in its first year of business, while a neighboring museum, the Welsh Industrial and Maritime Museum, with its traditional display approach saw only 39,000 people in 1990. The analysis performed by Caulton leads us to believe that “These statistics illustrate

the public appeal of hands-on centres compared with even recent traditional object-based exhibitions” (Caulton, 1998). As funding increased, Technique was able to add more and more interactive exhibits. This is especially evident in the large increase in number of visitors in 1995 and 1996.

Studies authored by Arthur Melton demonstrate how the location of an exhibit, the size of the museum, and even the location of exits all contribute to the overall allure of each exhibit. For example, Melton found that visitors tend to turn right when they first enter, and also take the first exit they come to (Melton, 1972). Modern approaches to some of Melton’s research have tried to make use of computer tracking equipment to more effectively reach outcomes, but the complexity of visitor behavior goes beyond the information a computer tracking system can provide. There are too many other miscellaneous factors that can contribute to a visitor’s behavior that no explicitly defined computer algorithm can account for them all. Nurin Veis, Manager of Scienceworks at Museum Victoria, stated that these factors, and associated effects, can be bent to the will of a museum: for example, placing a highly anticipated exhibit at the rear of an exhibition hall causes a “milk in the grocery store effect” by forcing patrons to walk past all the other exhibits before reaching the flagship exhibit, whatever it may be (Veis, 2015).

2.3 Interactive Exhibits and Scienceworks

Museum Victoria, located adjacent to Melbourne Victoria’s Central Business District, represents the largest museum complex in the southern hemisphere (“Melbourne Museum: a building for the 21st century”). Over the years, Museum Victoria has become more involved in assessing visitor interactivity at its museums thanks to insight provided by researchers like Janette Griffin at the University of Technology in Sydney, and the MARVEL institute of museum visitor tracking that have studied visitor interactivity at other Australian museums. The Scienceworks venue of Museum Victoria has taken the initiative to provide high quality exhibits to their patrons, citing that, “The way that visitors interact is changing. Many people wish to become more active

participants in their cultural experiences: to personalise, communicate and share with others” (Museum Victoria Strategic Plan, 2013). With this philosophy in mind, Museum Victoria has continuously updated their museums in order to provide the best experience possible for their visitors.

To deliver on the goal of active participation, the Scienceworks venue of Museum Victoria has become an early adopter of interactivity in their exhibits. One of these exhibits is Think Ahead, which contains “innovative technology with hands-on experiences to inspire you to research, think creatively and share your ideas” (“Think Ahead”, 2015). As the concept of interactive exhibitions has only become popular within the last twenty years, there is still much research waiting to be done in the field to determine the best practices when designing these exhibits (Caulton, 1998).

Scienceworks is currently researching methods to further engage visitors with fun, interactive displays. Their prime concern is providing the highest quality of education for their younger visitors and introducing them to STEM fields at an early age. This a prime concern because over the last decade, the number of students currently pursuing engineering and sciences has risen only one percent (Korn, M., 2015); introducing younger visitors to STEM earlier may help to increase this staggeringly low percentage. Quite often, a good way to introduce STEM related topics to children is to physically show them the relevance the subject has in their own lives. Examples outside a museum include: taking apart household appliances, stargazing with a telescope, or watching airplanes land at a local airport. Scienceworks strives to, “make learning about science and technology a fun, interactive adventure ... present[ing] science and technology in unexpected and involving ways” (“About Us” 2015).” As a leading innovator in the museum industry, Scienceworks and Museum Victoria have taken the responsibility to provide an appealing and effective method to introduce STEM to the new generation.

The Museum Victoria staff have conducted many internal reviews of their exhibitions, measuring various metrics of success, from holding times (the amount of time a visitor spends at a given exhibit) to the number of times visitors interact with certain elements. The Scienceworks team have conducted similar studies, but the purpose of most have been to provide internal review boards and administration with an effective measure of the attracting power of exhibits. Now, an objective of the museum is to develop a benchmark of learning opportunities and knowledge retention for future projects.

How children learn while visiting museums is influenced by the conversations they have with family members and by how the material is introduced in an academic setting (Chouinard, 2007). Conversation is an essential part of how children learn and is sometimes a necessary condition for learning to take place (Wells, 1981). The parents play the role of a teacher when introducing their child to a subject outside of the classroom, thus it is critical that parents and children converse in order for the children to have opportunities to ask their parents questions and learn more effectively.

In a study of a class field trip to a zoo, the investigators found that the children who knew they were going to the zoo and expected to see and learn about animals were more receptive to information provided in the classroom (Falk & Dierking, 1992). However, the children who were

not going to the zoo were not as receptive to the same information in a classroom setting. Introduction to a subject predisposes children to learning. Falk and Dierking go on to say that “actually seeing all the animals was the most reinforcing learning condition, but the very act of going to the zoo was sufficient to enhance concept learning over classroom-bound peers” (Falk & Dierking, 1992, pg. 35).

Even though this study refers to zoos, the same concept of visual and interactive learning still applies in a science museum setting. Unfortunately, knowing what information museum patrons understand before and after their visits is rare, and judging the learning that took place solely as a result of the museum is even more difficult to accomplish.

2.4 The Difficulty of Correlating Engagement to Learning Opportunities

In order to determine the extent of engagement a visitor is having with a particular exhibit, the ideas of holding and attracting power can be important factors. Holding power, or how long a visitor stays at an exhibit compared to the designed time of stay, can give museums insight to how their exhibits are being utilized. Similarly, attracting power is a term that describes how many visitors an exhibit garners the attention of. These two measures are the most frequently used statistics by museums (Donald, 1991). Although holding power and attracting power provide insight to characteristics such as intrigue and engagement level, other factors such as visitor interactivity and receptiveness to learning opportunities provide any researcher with the ability to analyze the museum experience even further.

Analyzing visitor interactions gives us information pertaining to engagement and popularity of the exhibits; however, education cannot be directly measured within the confines of the museum spaces (Serrell, 2015). For example, one may observe a visitor interacting with an exhibit that may or may not be teaching that person something new. Without formal examinations, the academic knowledge gained by a trip to a museum cannot be concretely concluded (Meehan, 2015). It is understood “that learning by people of any age is not simple and cannot be measured using simple tools” (Griffin, 2005). It is important to note that “learning” cannot be reduced to a condition of either taking place or not.

Timed or location data captures no information that can help distinguish an experience as either educational or not. Ideally, we would be able to definitively determine whether a child was “inspired and motivated by the exhibits and viewed the visit as an enjoyable educational experience, not just a giant fun-fair” (Caulton, 1998, pg. 21). One potential method for capturing a visitor’s overall educational experience is by observing their behavior throughout their stay.

2.5 Behavioral Indicators of Learning

Several methods of gauging learning opportunities in exhibits are currently being explored by museum staff to provide a correlation between engagement and actual learning. In a few instances, museum researchers observe visitors during their stay and make various notes about “behavioral indicators” that visitors exhibited (Griffin, 2005). These indicators might include:

pointing or gesturing to an exhibit item, visibly stopping to read placards, or simply the pace at which they are walking.

In the Museums Actively Researching Visitor Experiences and Learning study (MARVEL), completed by Janette Griffin, one component of the study was searching for behaviors that indicate that learning may be occurring. Each of these indicators accurately depicts the level of engagement the visitor has with the various museum spaces, and metrics may be defined to classify one's relative engagement (*Assessing Co-Scholastic Areas*, 2015). For example, a point system could be developed and a specific qualitative phrase can be assigned to specific ranges to give an accurate representation concerning visitor engagement. Hypothetically, if a visitor has a total of thirty-six points based on his/her total amount of behavioral indicators, he/she may be considered to have had a "Good" level of interaction with the exhibits, depending on the point scale that is created (*Assessing Co-Scholastic Areas*, 2015). Although the study cited makes use of letter scores and a composite score, rather than numbers, the point still stands. Since the amount of knowledge gained from a museum exhibit cannot be formally assessed, quantifying these indicators will provide the next best alternative.

Grading a visitor, or child's inclination towards learning and engagement is difficult, but by compartmentalizing related behaviors and actions, an assignment of a composite score is possible. In the past, spreadsheets with checkboxes containing various behavioral indicators were utilized to ultimately produce a graphic depicting the number of learning opportunities the visitor accrued throughout their visit (Meehan, 2015). These educational experiences are coined "learning opportunities" because learning cannot be proven through visitor observation.

However, these behavioral indicators can provide means to a predictive element for educational value that visitors may be absorbing. To bridge the gap between behavioral indicators and education, we must have substantial evidence that these indicators do in fact show the potential for learning. There have been controlled experiments that capture and correlate behaviors in specific "learning episodes" to formal knowledge gained. For instance, "Griffin (1999) created a visual observation tool for determining school children's engagement in learning in a museum setting. It uses a set of learning behaviours derived from research into behaviours that are exhibited during learning episodes" (Griffin 2005). Behavioral indicators are a critical supplement to both holding and attracting power in that they explain what draws visitors to particular exhibits and can lead to inferences that the visitor is being educated by the exhibit (Griffin, 2005). Holding power and attracting power only demonstrate that an exhibit is popular, but without any additional constituent elements the reason behind the popularity or lack thereof remains unknown. By employing different metrics for measuring visitor engagement, a new perspective can inform staff how visitors interact with the museum around them.

2.6 Various Tracking Techniques

The word "tracking" is ambiguous, as it can be used to indicate positional logging, observation, and timing. In the case of studies at Scienceworks, the word "tracking" encompasses all three of these components. With respect to positional tracking, several techniques have been

assessed at Scienceworks and Museum Victoria. Seeking an alternative to paper and pen tracking, the museum launched an investigation into the best possible means of visitor tracking in the future. While adoption of the more advanced tracking systems recommended by this study was halted due to a reallocation of resources, the knowledge gained through the study remains (Escuer, P., Mateo, A., McConnell, C., Schutes, J., 2014). A step towards a twenty-first century tracking method would be to implement an existing electronic tracking package. The price reduction associated with some methods of electronic tracking alternatives, such as Radio Frequency Identification (RFID), allows most venues to explore such technology and the benefits they offer. Unfortunately, electronic methods fail to capture nearly all of the human factors discussed above, and often do not track position with a high enough resolution to produce accurate continuous pathing data. Electronic tracking means may produce the numbers that shareholders like to see, but as any social entrepreneur will tell you, there is so much more to a successful impression upon your visitors than the apparent numbers. Stephen Weil, a scholar at Smithsonian Institution's Center for Education and Museum Studies, stated that "...museums must now compete with each other not for the best exhibitions and the highest attendance but, rather, to 'make a difference' (Smithsonian Institution, 2002)."

Conducting interviews, gathering demographics about visitors and selecting key insights from this data, such as general exhibit effectiveness and potential misunderstandings, would allow exhibit designers to improve visitor learning. A short conversation with the visitor might inform planners about characteristic visitor motivation. "If visitors' remarks suggest that there is a design or installation problem (as opposed to visitors' personal preferences), changes can be made to the prototype to alleviate the problem" (Korn, R., 1994, pg. 4). Additionally, "...it is also worth analysing your audience in two or more different ways in order to gain a clearer picture of their deeper lying motivations and expectations" (Poole, 2015). Identifying the incentives for visitors to attend a museum as well as observing their behavior and commentary at certain exhibits will aid the museum in making proper adjustments concerning visitor-exhibit interaction.

3. Methodology

This project goal was to observe visitors in Scienceworks of Museum Victoria, evaluate how they used exhibits, and provide recommendations about future exhibit designs. The primary focus was to observe behavioral indicators of learning and the visitors' physical interactions with the exhibits in order to rank visitor experiences and determine to what extent the exhibits were being utilized. To guide productivity and facilitate achieving the project's goal, the following objectives were created:

1. Self assess a baseline for visitor timing and interactivity at exhibits using the developed tracking instrument and categorize exhibits based on central themes.
2. Obtain visitor timing data across all exhibits, including holding time, transit time, and comparison with designed data.
3. Track visitor position and behavioral indicators of learning at each exhibit to determine relative attracting power and level of engagement.
4. Benchmark the current interactivity of museum spaces and engagement level by numerical analysis of tracking data.

In this chapter, we describe the methods used to accomplish these objectives: pen-and-paper positional tracking, timing, surveys, and observation of visitors' behavior. A previous Worcester Polytechnic Institute project at the Melbourne Museum implemented a pen-and-paper positional tracking method, which was slightly modified by our team to allow for more flexibility in timing and positional tracking (Escuer, P., Mateo, A., McConnell, C., Schutes, J., 2014). Also in this chapter, we discuss the analytical methods to translate the raw data to engagement scores.

3.1 Objective 1 - Create a baseline for observation study

In order to have a better foundation for our study, we decided to inspect a specific set of exhibits and determine how long it took to complete each interaction at these exhibits. The team created a benchmark by interacting with each of the exhibits ourselves at a set pace. The benchmark is an estimate of "design time" spent at each exhibit element (Serrell, 1998). The design time can be defined as the target length of time an average visitor would spend at the exhibit to complete all interactions. The design time spent at each exhibit was determined by interacting with exhibit elements until the meaning of each exhibit was clear, and all placards were read. As recommended by Ting-Jui Chang in *Effects of Design Features on Visitors' Behavior in a Museum Setting*, a casual reading pace was established and used by our sample of four group members, who recorded the time it took to interact with each exhibit (Chang, 2008). In addition to reading and interacting with each exhibit, the types of interactions such as pushing, pulling, reading, etc. were also recorded. This assessment was only completed for nine specific exhibits of interest. These exhibits represented the three major exhibition halls of the museum as well as the three main types of exhibits. These types are: purely interactive exhibits, purely display exhibits, and a hybrid

of both. The set of nine exhibits consisted of three display type exhibits, three hybrid exhibits and three interactive exhibits. These were spread over the three main exhibitions so that we had one of each type from Nitty Gritty Super City, Think Ahead and Sportsworks.

The next step in our preparation was to take note of every possible interaction in the museum. Beverly Serrell piloted a majority of these general actions in her 1998 research, which is regarded by the Museum Victoria staff as a starting point for many of their observational studies (Serrell, 1998; Meehan, 2015). To create a baseline for the “design” time as well as determine possible interactions, three exhibits in each exhibition were chosen by the team and verified by the museum staff. This allowed us to cover a variety of exhibit types: fully interactive, a collection on display, and a hybrid of the two with both text and interactive elements.

Designed holding times and possible interactions with exhibits were then incorporated into a spreadsheet, known as the tracking instrument. The tracking instrument consisted of two parts. The first part was a demographic and general timing sheet to note times in and out of main exhibitions, the cafe, or play areas. It can be found in Appendix A. The second part was a detail sheet for each visitor observation containing more precise timing between individual exhibits, blank spaces to fill in which exhibits were visited, an area for notes, and a grid of the following interaction types: push, pull, turn, lift, legs, arms, full body, touch, create, hit, gesture, good conversation, bad conversation, read, texting, taking photos, observing, listening, and social play (Diamond, 2009). This grid was then populated with the number of times an interaction was observed at each exhibit. Both trackers verified the number before it was recorded in the tracking instrument.

As many of these numbers were dependent on what the tracking team considered single interactions, repetitious, or particularly noteworthy, a reproducibility study was conducted to ensure that the data was robust and that other tracking teams could repeat the procedure. The two non-tracking team members joined forces with a tracking team member towards the end of the observation period. The non-tracking team member was briefed with the tracking guide found in Appendix C, and subsequently attempted to record their own assessment of visitor interactions.

3.2 Objective 2 - Obtain visitor timing data

Our sponsor, Carolyn Meehan, Manager of Audience Insights at Museum Victoria, put specific emphasis on performing whole site visitor tracking in order to see what pathways guests take throughout the museum, as well how they interact with exhibits. Our mission was defined in a project briefing we received several months prior to conducting research, and it read as follows, “To observe and record visitors across the museum to show how they are currently using and learning in the museum spaces so that we can better activate these spaces for the future” (Meehan, 2015). We used a modified pen-and-paper positional tracking method to perform the whole of site tracks. A two-member team followed a child within a family unit around the museum throughout the course of their stay, taking note of which exhibits he or she visits and for how long. Visitor tracking was constrained to children between the ages of four and twelve in correlation to the museums target audience (Meehan, 2015). Guests were tracked with minute (sixty-second)

precision as they traversed the various exhibitions, much as described in other tracking studies (Serrell, 1998). The total duration was calculated by subtracting the time the visitor entered the museum from the time the visitor left the museum. Transit time was considered negligible if visitors travelled directly from a previous exhibit to another. The amount of time the visitor spent at various exhibits was recorded and later compared to the designed holding time determined in Objective 1.

Tracking was limited to children in families, rather than in larger school groups for several reasons. In Australia, school children wear nearly identical uniforms, including hats, making an individual child very easy to lose in the crowd. Secondly, at Scienceworks, school instructors schedule their day with the museum to coordinate with show times, staff availability, and to reduce congestion. School groups have been noted to move at a pace set by their leader in addition to being restricted to certain areas for different time slots. School children entering and exiting the museum were also found to be too difficult to interview, even with a short, visual, survey. The children that were chosen for the observation fell within the demographic criteria mentioned above as well as being visually identifiable. For instance, a child with a brightly colored backpack, or a child who is notably taller than other children would be considered visually identifiable (Gorman, 2008). The tracking team selected subjects upon entering the museum in order to keep the average age around the requisite eight years, and gender to a fifty-fifty ratio at all times during the study. This allowed for data analysis to take place at various times over the course of the study. Age was visually estimated, leading to some uncertainty, but research suggests that a fairly accurate age can be estimated by height within the Scienceworks target age range (Pellegrini, 2011). There was no preference to family size, but the average nuclear family of two parents and two children were the most frequent in the museum.

Visitors were never personally informed that they were the subject of an observational study, but were informed by posted signs at the front desk and information desk whenever various tracking activities may have been taking place. The tracking team wore business casual attire and clearly visible museum identification. If a guest questioned their identity as trackers, the tracking team was instructed to stop all tracking activity immediately. The tracking team ensured an average following distance of fifteen feet or more whenever possible, which although limited their ability to listen to visitor conversation, reduced the chances of being discovered as trackers (Catlin-Legutko, 2012). More details on specific tracking techniques can be found in the tracking guide presented in Appendix C of this report.

Once all tracks were completed, a brief survey was administered to families leaving the museum where responses were recorded for both children and adults. This survey was done separately from the visitors we tracked as the distance between the tracking team and the visitor tracked made it impossible to catch up to the leaving visitor. The purpose of this survey was to supplement the information about each sub-exhibit gathered from tracking. Children were asked which of the nine representative exhibits were their favorite and least favorite, while adults were asked which exhibit they found to be the most and least educational. Both were encouraged to answer by pointing to a grid of all nine exhibits presented on a poster-board. Images of each exhibit

were affixed to the board along with their names to guarantee that they were recorded properly (Wallace, 2010). The photos were taken when no one was present in the museum to eliminate distractions within the picture. The composition of each image was carefully designed to include an interactive element in the foreground, and the remainder of the exhibit in the background. In order to provide the most representative image of each exhibit, photos were taken from an angle similar to how a child might witness the exhibit. The survey group consisted of one interviewer and one recorder to prevent any loss of information during longer conversations. The interviewer approached families who showed an interest in the large colorful board of images, asking them simply to point out their favorite exhibit of the day (Wallace, 2010). If their level of cooperation was judged to be high, the interviewer continued with questions, not forcing negative answers, as not all subjects felt comfortable answering which exhibits were their least favorite. The recording member of the team took down responses as a simple tally for each question and each exhibit. After a brief conversation following an interview, the team also recorded quotes from adults regarding their children's experiences that day, or on previous trips to Scienceworks (Diamond, 2009). The survey questions and survey board can be seen in Appendix D.

3.3 Objective 3 - Track visitor position and behavioral indicators of learning

Maps depicting the pathways that visitors took at Scienceworks were drawn with the exhibits numbered on the map for reference. As visitors traversed the museum space, one member of the tracking team recorded their position on these maps in red ink. Care was taken to reference the position of visitors relative to fixed objects on the maps to create the most accurate hand-drawn track possible. The tracker is required to determine how much of each track to draw, as an exact track of a children's path lends itself to very noisy data. We determined that the tracker would only draw the pathways that the visitor took from each exhibit to the next, and not all movements within each exhibit. This allows the tracker to filter for only the most significant movements, as to not clutter up the tracking map. Additional considerations include scenarios like a child running back and forth from one exhibit to another in excess of twenty times. We opted to only record this as a single trip and note the iterations in the notes section. Determining how much of a path to draw is a simple process to learn and can be read about in more detail in the tracking guide in Appendix C.

The recorded paths were color scanned and post-processed by scripts written in popular graphics software packages, such as Adobe After Effects CS5.5 and Inkscape. The scripts and filters converted the hand-drawn tracks to Bezier curves in standard vector graphic format (*.svg) via a 16-bit color quantization and bitmap trace. This processing allowed us to produce visually clean overlays of all the tracks and to perform further analysis on the tracks to assess their directness, congestion, and the number of stops at exhibits.

In addition to positional tracking, behavioral indicators of learning were taken into account to determine the extent of interactivity a visitor was having with the exhibits. The interactions that

visitors performed, such as pushing, pulling, and creating, are all considered examples of behavioral indicators of learning. Although it cannot be proven that visitors learn something at the museum, presence of these behavioral indicators suggests the possibility of learning (Serrell, 1998; Jant, 2014). The level of engagement at each exhibit was measured by tallying the number of times the behavioral indicators of learning were entered in the visitor tracking instrument. As mentioned in section 3.1, this was highly dependent on a tracking team that agreed on sets of criteria to keep their numbers consistent. A list of the possible interactions and an explanation of what constitutes each can be seen in Appendix B.

Much like the positional tracking, rapid repetitious actions were not counted as multiple actions, but singular actions. For example, a child pushing a button to start a video five times in a row yields no more learning than pressing the button once and is thus counted as one push. Another action that was found difficult to enumerate was social play, as it is not a discrete action. One tally was awarded for every session of social play exhibited while interacting with either other children or adults. In order to be awarded multiple instances of social play, the child would have to stop playing with one child and play with a different one (Pelligrini, 2011). Some examples of social play found in Scienceworks are: 1) building a wall with foam bricks which requires cooperation to transport all of the bricks, loading cargo into a boat using a crane operated by two or more, and 2) creating a realistic wave motion with the caterpillar puppet in the Alice's Wonderland exhibition. While several of the exhibits where social play is applicable may be done alone, it is more desirable to have multiple people accomplish these tasks. Lastly, since the tracking team maintained a following distance that was often too far to hear visitors' conversations in the noisy environment, they relied on reading gestures and observing facial expressions to see when conversation about an exhibit was taking place. Cues such as pointing to exhibits and intently watching what was happening indicated a good conversation while crying, screaming or a hurried exit from the building indicated a bad or unrelated conversation. To make sure that both trackers were consistent, these interactions were often discussed before being marked down. Since it was easier to tell when guests were discussing the exhibits in front of them, and likely explaining content to their children, more instances of good conversation were recorded than bad. For a more detailed description of these interactions refer to the Interaction Descriptions in Appendix B and for more information regarding tracking protocols refer to the Tracking Guide in Appendix C.

3.4 Objective 4 - Benchmark the current interactivity of museum spaces

Previous studies, including some conducted by Museum Victoria, have recorded behavioral indicators of learning, but none have gone the extra step to normalize the numbers in the context of the entire museum and scale the interactions based on their educational value (Simon, 2015; Griffin, 2005). In order to correlate the level of engagement to the educational value of the exhibit, the number of times and means by which visitors interact with exhibits must be assigned a value system (Griffin, 2005). The list of interactions presented in the tracking instrument aims to cover positive interactions to which various multipliers are applied. For example, creating is known to engender additional teaching by use of imagination to convey

thoughts into the real world; therefore, it is the most highly rewarded of all interactions (Pelligrini, 2011).

Originally there were several additional indicators that were eliminated because of the low frequency that they occurred; however, some of these actions may be more prevalent in other venues. Taking selfies and asking questions were both omitted because of difficulties distinguishing them from other actions. General photography remained in the interaction list, but was only recorded if a child asked a parent to take a picture of an exhibit, or they took the picture themselves. In the same vein, a convention was also created to deal with actions that encompassed more than one interaction. For instance, this convention was applied to the car making exhibit in Think Ahead. Children interact via touch screen to create a car design that is then projected on a screen. Creating one car nets both a ‘touch’ interaction and a ‘create’ interaction. Finally, if a stop was made at an exhibit, but no visible interaction took place, then times were still recorded, but “no interaction” was written in the notes section.

An interactivity multiplier represents the amount of commitment and engagement required to perform a specific interaction. Some examples include: reading, creating, and pushing buttons.

Interaction Codes		Points
Push		1
Pull		1
Turn		1
Lift		1
Legs		1
Touch		1
Arms		1
Body		2
Create		3
Hit		1
Read		2
Watch		1
Hear		2

Table 1: Interactivity Multipliers for Creating Engagement Scores

The interactivity multipliers, seen in Table 1 above, ranging from one to three, were applied to all interactions that took place at a specific exhibit, with the same multipliers used across all exhibits. These multipliers were applied during analysis by the non-tracking team after the tracks were completed. Before applying the multipliers, the number of times that an interactive item was used by visitors had to be normalized across the whole museum. For instance, if an exhibit contained twenty push buttons, while another only contained one touch screen, the level of engagement represented by the unnormalized data would always favor the exhibit with twenty push buttons, so long as two or more were pressed. By forming the ratio of number of uses of each element to the total instances of that element in the museum, the resulting multipliers represented a normalized contribution by each button pressed, ball thrown, etc. These multipliers were never

shared with the tracking team. This way the tracking team could not be biased when assigning number of interactions for the tracks. One thing to note is that certain interactions such as social play and photography cannot be normalized, as there is not a total possible number that can take place. These interactions could not be included in the total engagement score for this reason. These interactions are noted solely for observation-based analysis.

In order to compute an engagement score, representing the level of interactivity a visitor had during his/her stay, the following steps were taken. First, we summed the total number of each type of interaction (i.e. eight pushes) then normalized the contributions of each interaction (i.e. eight pushes by the visitor divided by sixteen total possible pushes throughout the entire museum). Next, as described in the previous paragraph, we multiplied each contribution by its respective multiplier (0.5 multiplied by one point per push). A 10X multiplier was applied to each contribution (0.5 multiplied by 10 in this case). This results in a contribution of 5 from the push interaction. This calculation is then done for each subsequent interaction. This provided us with each component of the engagement score, which we then added up to achieve the final engagement score. The equations that show how an engagement score is calculated and an example of the calculation are shown below (Figure 8). An example of a resulting engagement score from adding all the individual engagement scores is 56.3. These scores then became the basis for some of our findings.

$$\frac{\text{\# interactions completed}}{\text{total possible interactions}} \times \text{interaction multiplier} \times 10 = \text{Engagement Score}$$

$$\frac{8 \text{ pushes}}{16 \text{ possible}} \times 1 \text{ point per push} \times 10 = 5$$

Figure 8: Engagement Score Equation and Example Calculation

4. Findings

This chapter presents the data from our observational study as well as the results of our analysis to determine: 1) how visitors are currently using the exhibits at Scienceworks, and 2) how the exhibits can be altered to deliver a more engaging experience to the visitors. In order to best present our findings, the chapter starts with insights about our methods. This chapter continues with findings based on the interactions that museum visitors complete when at exhibits in the museum. The chapter continues with findings about specific exhibits and exhibitions. Finally, this chapter concludes with information on the museum as a whole. The layout of this chapter allows us to focus on themes present in each tier of museum organization. Museums inherently have four tiers of organization that flows from what is done at each exhibit, to the exhibits themselves, to the exhibition, and finally to the museum as a whole. By organizing our findings this way, we are able to look in depth at each one of these areas while slowly building to the broadest ideas. To see the details and maps of each of the twenty-one tracks, refer to Appendix F.

4.1 Findings Involving Our Methods

Our main method was completing a series of whole of site tracks at Scienceworks. We were able to complete twenty-one tracks over a span of sixty hours. This might seem comparatively low to past projects since Museum Victoria usually completes forty tracks for their observational studies. The reasons we believe this number is valid for our research are explored in this section. A few limitations to this study are also discussed in this section. We do not believe these limitations affected our results; however, they provided possible avenues for future study. This section also covers the validity and repeatability of our methods.

4.1.1 Twenty-one tracks are sufficient for analysis due to hours spent tracking and the distribution profile.

One of our limitations was that we were only able to complete twenty-one tracks when the museum normally completes close to forty. We completed around sixty hours of tracking. When compared to other studies that were done on specific exhibitions instead of a whole of site, the time spent collecting data was similar. Additionally, our distribution of engagement scores fits the bell curve of a normal distribution thus indicating validity. An engagement score was a metric we developed to represent the interactivity of a visitor. This score represents a higher or lower potential for learning. The step-by-step engagement equation, which shows how an engagement score is computed, can be found in section 3.4.

Figure 9 presents the engagement scores on a standard bell curve. The red line shows the characteristics of a normal distribution, such that approximately 68% of the data will fall within one standard deviation of the mean engagement score. The blue line represents our data. It fits on the bell curve with the exception of a few outlying engagement scores. These outliers were a result of higher engagement scores during weekend tracks. The difference between weekday and weekend data is discussed further in section 4.1.3. The distribution of our data validates our

methodology in that our weighting of interactivity factors was reasonable and only slightly favored the higher end of the spectrum. Table 2 shows our weighting of the various interactivity factors. Some interactions were awarded more points than others due to the extent of the engagement required to perform them. For instance, create was worth three points and pushing a button was worth one because it requires more commitment to build a wall than simply push a button. The distribution of our data is broken down by how many tracks were in each range in Table 3 and shows the slight favorability to the higher spectrum.

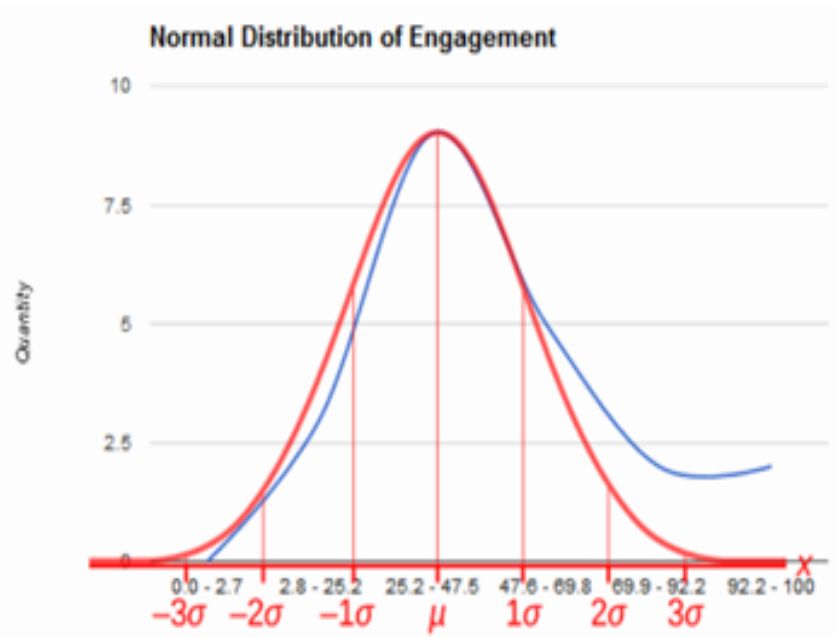


Figure 9: Normal Distribution of Engagement Scores

Interaction Codes		Points
Push		1
Pull		1
Turn		1
Lift		1
Legs		1
Touch		1
Arms		1
Body		2
Create		3
Hit		1
Read		2
Watch		1
Hear		2

Table 2: Interactivity Multipliers for Creating Engagement Scores

Distribution	
Score Range	qty.
0.0 - 2.7	0
2.8 - 25.2	3
25.2 - 47.5	9
47.6 - 69.8	5
69.9 - 92.2	2
92.2 - 100	2

Table 3: Distribution of Engagement Scores

4.1.2 Our research team's tracking methods are repeatable.

Team members who completed tracks paired up with members who had not completed tracks to see if the methods could be repeated. After a brief introduction to the method, practice tracks were held and the data collection (non-experienced) team was able to produce nearly identical results to the experienced team, as can be observed in Table 4. Everyone in our team participated in at least one track to verify that the scoring and tracking methods were not biased. Determining that our tracking and scoring methods are reproducible indicates that Scienceworks can repeat this method in the future to increase the number of tracks or to analyze new exhibits. One limitation in this reproducibility study was that due to time constraints we were not able to have someone from Scienceworks look over our tracking methods and interaction descriptions to see if they had any questions. This could mean that there are a few gaps in reproducibility. To aid Scienceworks in future studies, the tracking team created an in-depth tracking guide containing the materials, procedures, and definitions that someone would need to reproduce our methods. This guide can be found in Appendix C.

Feasibility Study Results						
Track	Interactions		Proximity of Measurement			
	Points	Types	Difference	Dissimilar	Precision	Accuracy
Expert1	69	38	1	8	99%	100%
Student1	68	38				
Expert2	69	42	0	2	100%	98%
Student2	69	41				
Expert1	98	65	6	6	94%	96%
Student1	92	68				
Expert2	45	27	2	3	95%	93%
Student2	43	25				
Baseline: 			What was the total accumulated difference in point score between the two?	How many of the boxes in the matrix had a recorded difference between the two?	How far is the spread between the two accumulated scores? $\frac{[av(points) - difference]}{av(points)}$	How many interaction types is the difference distributed across? $\frac{(types/types) * dissimilar}{}$
Subjects: 						

Table 4: Feasibility Study for Reproducing Methods

4.1.3 A statistically significant difference exists between weekday and weekend data.

The results from weekend tracks yielded a difference in engagement scores. We took into account the number of interactions performed by the child, the number of possible interactions in the museum, and used our weighting system to develop the engagement score. The weekday average engagement score was 44.8 and the weekend average score was 71.2; this indicates a difference in amount of interactivity leading to a higher level of engagement. Children during the weekend tracks made more stops on average (36.8) than the children during the weekday tracks (27.7). The time spent at Scienceworks was also different. The average weekday duration was two and a half hours while the weekend's average was a little over three hours. Our conjecture is that this difference in engagement score is a result of visitors having more time to spend at Scienceworks during the weekend, leading to more opportunities to interact with the exhibits. We found that weekend visitors' pathways were no different than the weekday visitors' pathways. It should be noted that the average age of the children tracked on the weekend were older than those tracked during the weekday, with the average for weekdays being six years of age and the average for the weekend being ten years of age. Since we were not getting many older children during the week, as they were likely in school, we aimed to track older children on the weekends. This allowed us to have a wide spread of ages in our full data set. The age difference of the tracked visitors on the weekday versus the weekend may contribute to the higher weekend engagement score.

There was one other distinction between weekends and weekdays at Scienceworks. The weekdays can be quite congested with visiting school groups. While tracking families during the week, we observed that some children with their parents moved away from certain exhibits due to the presence of these large school groups. It was evident that these older children influenced the parents of younger children to move to a less congested area. Several minimally supervised school children running around in one area not only created a lot of noise and room for injury to younger children, but the lines for exhibits became longer. During many tracks, children exploring an area that had a school group in it did not get a chance to interact with certain exhibits due to these long lines. Some children in a family group waited for their turn, but most grew impatient of the lines and moved on. The more peaceful environment on the weekends allowed children to explore the museum at their own pace, leading to children interacting with the museum spaces more frequently and for longer periods of time.

4.2 Findings Involving Interactions at Scienceworks

In order to better understand how visitors used the exhibits, we had to explore the specific interactions the visitors had with these exhibits. This involved tracking visitors across their whole stay and observing how they behaved. Before we started tracking we had to come up with a list of interactions to look for and determine what they meant. This list and description of each interaction can be found in Appendix B. These interactions were then marked down and input into a spreadsheet to be analyzed. We performed a total of 21 tracks across a span of 60 hours to gather enough data to analyze. In order to analyze these interactions, we converted them into a combined engagement score. This score shows us how engaged the visitor tracked was and whether they had a higher potential for learning from their experience. We also looked at the interactions individually to see if any patterns emerged. Some of these patterns can be seen in Table 5. The first column is the name of the interaction and the following 21 columns are each of our respective tracks. The totals of each interaction from each specific track appear in these columns. The second to last column is the average number of that interaction per track and the last column is the total number of possible times that interaction could be completed in the museum. As you can see, the most prevalent interaction was the push interaction averaging 23 per track. This could be due to the fact that there are a number of buttons in the museum and/or that pushing a button is an easy interaction to accomplish.

Museum Interactions																						
Interactions	Track Number																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Average
Push	20	26	3	52	22	32	24	6	39	4	17	11	38	19	5	23	26	30	54	26	39	23.9
Pull	3	5	9	11	0	6	9	0	1	0	0	1	3	2	3	8	3	0	0	10	16	3.7
Turn	23	14	8	13	28	12	12	10	16	6	5	12	15	6	11	25	22	16	4	23	11	14.1
Lift	21	23	8	14	11	2	9	6	19	0	2	4	7	6	9	4	4	21	2	11	12	9.2
Legs	4	1	1	0	5	4	0	3	3	2	1	1	1	5	0	7	3	0	5	0	5	2.3
Touches	8	13	17	5	19	20	18	3	20	19	3	6	8	29	13	24	28	3	16	9	18	14.1
Arms	2	1	4	0	12	5	7	1	7	3	1	1	2	6	0	7	5	33	13	3	9	5.7
Body	1	6	5	7	20	3	2	2	5	9	6	3	8	8	7	6	8	6	22	13	17	7.4
Create	2	7	7	7	12	5	10	4	13	7	5	1	4	11	5	7	17	3	7	3	9	6.9
Hit	0	20	0	0	0	0	0	0	1	0	0	9	0	0	0	6	7	4	26	0	14	3.7
Read	4	1	2	0	11	14	1	0	1	3	0	3	1	26	0	13	20	0	14	2	10	5.8
Watch	6	9	5	11	20	19	14	8	24	11	8	10	4	29	6	25	26	9	36	5	22	14.3
Listen	1	0	1	0	1	2	1	0	1	1	0	1	1	3	0	1	6	0	3	2	2	1.3
																						Total in Museum
																						115
																						9
																						66
																						42
																						6
																						93
																						16
																						12
																						21
																						23
																						253
																						51
																						17

Table 5: Interactions by Track

We also explored a few different aspects of interaction and engagement score data including utilization of exhibits and correlations to non-interaction based factors. We were able to explore correlations with age, stops, and gender, with our engagement scores, pictured below in Table 6. These correlations are discussed further in this section.

Engagement Scores			
Track Number	Score	Track Number	Score
1	29.5	12	21.6
2	49.7	13	35.5
3	40.2	14	61.6
4	44.1	15	28.9
5	82.9	16	64.1
6	43.2	17	75.4
7	44.0	18	45.8
8	20.0	19	93.4
9	56.3	20	52.0
10	37.0	21	96.3
11	24.2		

Table 6: Engagement Scores by Track Number

One final method we used was conducting surveys. This data can be seen in Table 7. We asked visitors leaving the museum what their favorite and least favorite exhibits were, as well as

what exhibits they felt were the most and least educational. This helped us gauge visitor sentiment about different types of exhibits and interactions at Scienceworks.

Survey Results							
Type	Exhibit	Favorite		Educational		Totals	
		Most	Least	Most	Least	Most	Least
Display	Microscopes	0	3	0	1	4	13
	Communication	1	3	1	2		
	Sports Safety	1	4	1	0		
Hybrid	Recycling	3	2	10	0	23	12
	Sound Room	3	4	0	3		
	Visual Illusions	4	3	3	0		
Interactive	Wall Building	15	1	3	0	40	6
	Future You	7	1	4	0		
	Race	11	1	0	3		
	None	0	0	0	4	0	4

Table 7: Favorability Survey Data

4.2.1 Interactive exhibits are more fun and offer more learning opportunities than the display and hybrid (contain both display and interactive elements) exhibits.

During our analysis we decided to look at how different types of exhibits were used by dividing the number of interactions that took place at the exhibit by the total number of possible interactions, resulting in a percent utilization. These were reported as percentages and can be shown by track in Table 8 below. This table summarizes interactions for nine exhibits, three from each of the major exhibition areas (Nitty Gritty Super City (NGC), Think Ahead (THA), and Sportsworlds (SPW)). These exhibits were chosen because they best represented their exhibitions as well as the three different types of exhibits. Additionally, they were approved by the museum staff. These three types were display based exhibits, interactive based exhibits, and a hybrid of both types.

Exhibit	Possible	1	2	3	4	5	6	7	8	9	10	11											
Nitty Gritty Super City: Microscopes	14	3	21.4%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4	28.6%			0	0.0%		
Nitty Gritty Super City: Wall Building	38	17	44.7%	10	26.3%	16	42.1%	38	100.0%	4	10.5%	8	21.1%	27	71.1%	3	7.9%	8	21.1%		18	47.4%	
Nitty Gritty Super City: Recycling	34	4	11.8%	7	20.6%	6	17.6%	0	0.0%	2	5.9%	1	2.9%	3	8.8%	0	0.0%	3	8.8%		7	20.6%	
Sportsworks: Visual Illusions	53					0	0.0%	0	0.0%	22	41.5%	14	26.4%			0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sportsworks: Sports Safety	15					3	20.0%	0	0.0%	4	26.7%	0	0.0%			0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sportsworks: Race	16					4	25.0%	4	25.0%	5	31.3%	2	12.5%			3	18.8%	14	87.5%	6	37.5%	16	100.0%
Think Ahead: Communication	22					0	0.0%			2	9.1%	0	0.0%	3	13.6%	3	13.6%	0	0.0%	0	0.0%	0	0.0%
Think Ahead: Future Ahead	18					6	33.3%			37	205.6%	19	105.6%	6	33.3%	0	0.0%	7	38.9%	12	66.7%	0	0.0%
Think Ahead: Sound Room	21					6	28.6%			0	0.0%	0	0.0%	4	19.0%	0	0.0%	0	0.0%	5	23.8%	0	0.0%
Exhibit	Possible	12	13	14	15	16	17	18	19	20	21	Average											
Nitty Gritty Super City: Microscopes	14	2	14.3%	0	0.0%			0	0.0%	1	7.1%	4	28.6%	0	0.0%	0	0.0%	1	7.1%	2	14.3%	6.4%	
Nitty Gritty Super City: Wall Building	38	2	5.3%	17	44.7%			2	5.3%	8	21.1%	5	13.1%	52	136.8%	2	5.3%	37	97.4%	40	105.3%	43.5%	
Nitty Gritty Super City: Recycling	34	5	14.7%	0	0.0%			0	0.0%	2	5.9%	12	35.3%	3	8.8%	3	8.8%	2	5.9%	0	0.0%	9.3%	
Sportsworks: Visual Illusions	53	0	0.0%	0	0.0%	0	0.0%	0	0.0%	30	56.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	6.9%	
Sportsworks: Sports Safety	15	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	6	40.0%	0	0.0%	0	0.0%	4.8%	
Sportsworks: Race	16	7	43.8%	14	87.5%	12	75.0%	10	62.5%	7	43.8%	6	37.5%	27	168.8%	35	218.8%	18	112.5%	30	187.5%	76.4%	
Think Ahead: Communication	22	0	0.0%	0	0.0%	10	45.5%	0	0.0%	0	0.0%	8	36.4%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	6.6%	
Think Ahead: Future Ahead	18	1	5.6%	6	33.3%	16	88.9%	10	55.6%	1	5.6%	22	122.2%	0	0.0%	46	255.6%	6	33.3%	20	111.1%	66.4%	
Think Ahead: Sound Room	21	3	14.3%	0	0.0%	8	38.1%	0	0.0%	0	0.0%	11	52.4%	0	0.0%	9	42.9%	5	23.8%	21	100.0%	19.1%	

Table 8: Percent Utilization by Track

The data in Table 8 was then condensed into Figure 10, which shows the three exhibitions, and the types of exhibits (display (blue), interactive (orange), and hybrid (red)), on the horizontal axis. On the vertical axis, the percentage of interactions completed on average is shown. Determining what types of exhibits offer the most learning opportunities and are the most popular for children essentially benchmarks the effectiveness of the various types of exhibits. We defined a learning opportunity by the number of possible interactions that a child can take part in at a given exhibit. By looking at the Figure 10, it can be seen that at Think Ahead, Sportsworlds, and Nitty Gritty Super City, the interactive exhibits are utilized much closer to their full potential than the display and hybrid exhibits. Full potential is defined by the total amount of learning opportunities that are present at a certain exhibit. Table 8 and Figure 10 both show that children are more intrigued and drawn to the interactive exhibits.

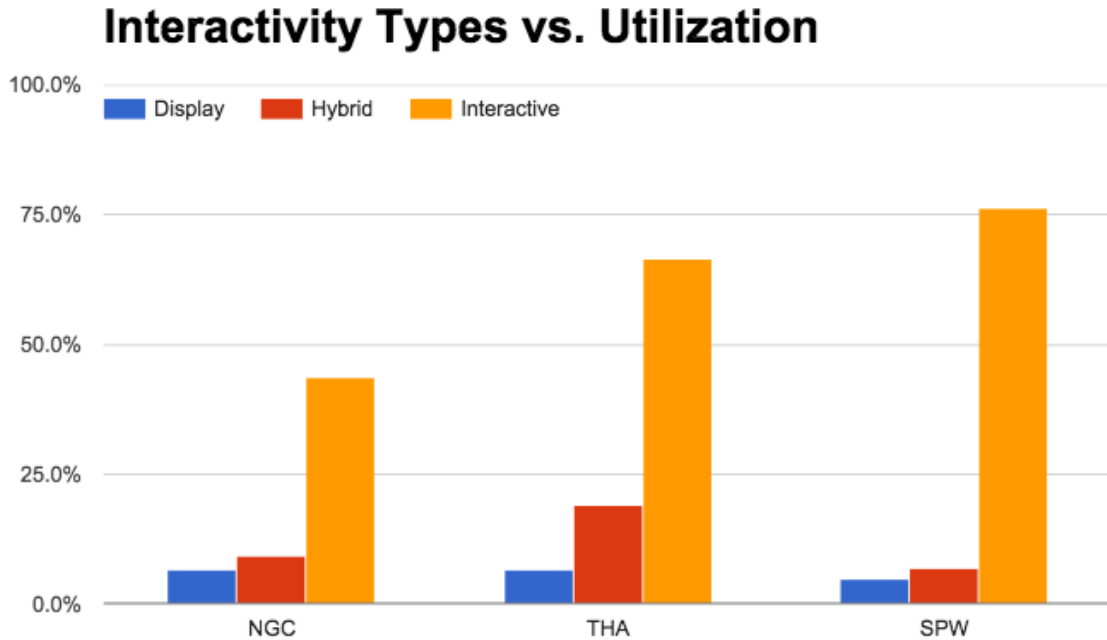


Figure 10: Utilization Averages by Exhibit Type

Figure 11 shows the three types of exhibits and the number of visitors who gave positive or negative responses towards those types of exhibits in our post-visit survey. Based on the responses, the interactive exhibits received the highest amount of positive feedback. This means that many visitors picked out the interactive exhibits as their favorite and as the most educational. The display exhibits were picked more often as the least favorite and least educational.

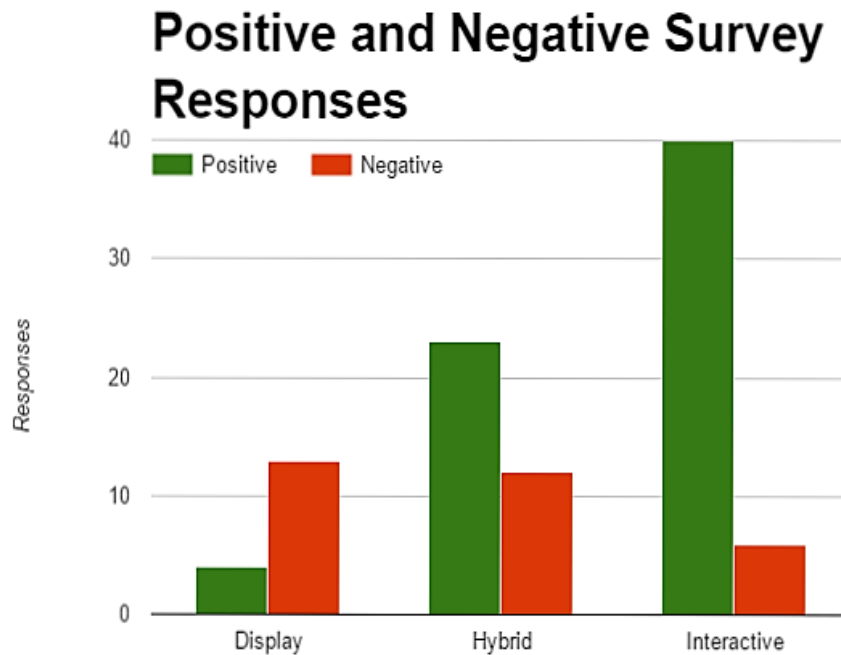


Figure 11: Positive and Negative Survey Responses by Exhibit Type

Figure 12 is a scatterplot of engagement score versus favorability for the nine exhibits. The engagement score, as previously mentioned, is a representation of how engaged a visitor was at Scienceworks. In this plot, engagement is either ‘passive’ or ‘engaged’, where passive is a low engagement score and engaged is a high engagement score. Favorability is how well liked the exhibit was. This was calculated using the responses to our survey. On the plot, favorability is either ‘positive’ or ‘negative’ where positive means that more visitors picked that exhibit as their favorite and negative indicates that the exhibit was picked as the least favorite more often. It can be observed from the plot that the display type exhibits all fall in the passive/negative quadrant (blue area), meaning that they neither receive much interaction nor are very favorable. The hybrid exhibits all fall in the ‘engaged’ half of the plot (red area), but some are favorable while others are not. All of the interactive exhibits fall in the engaged/positive quadrant (orange area), suggesting that they are both engaging and favorable.

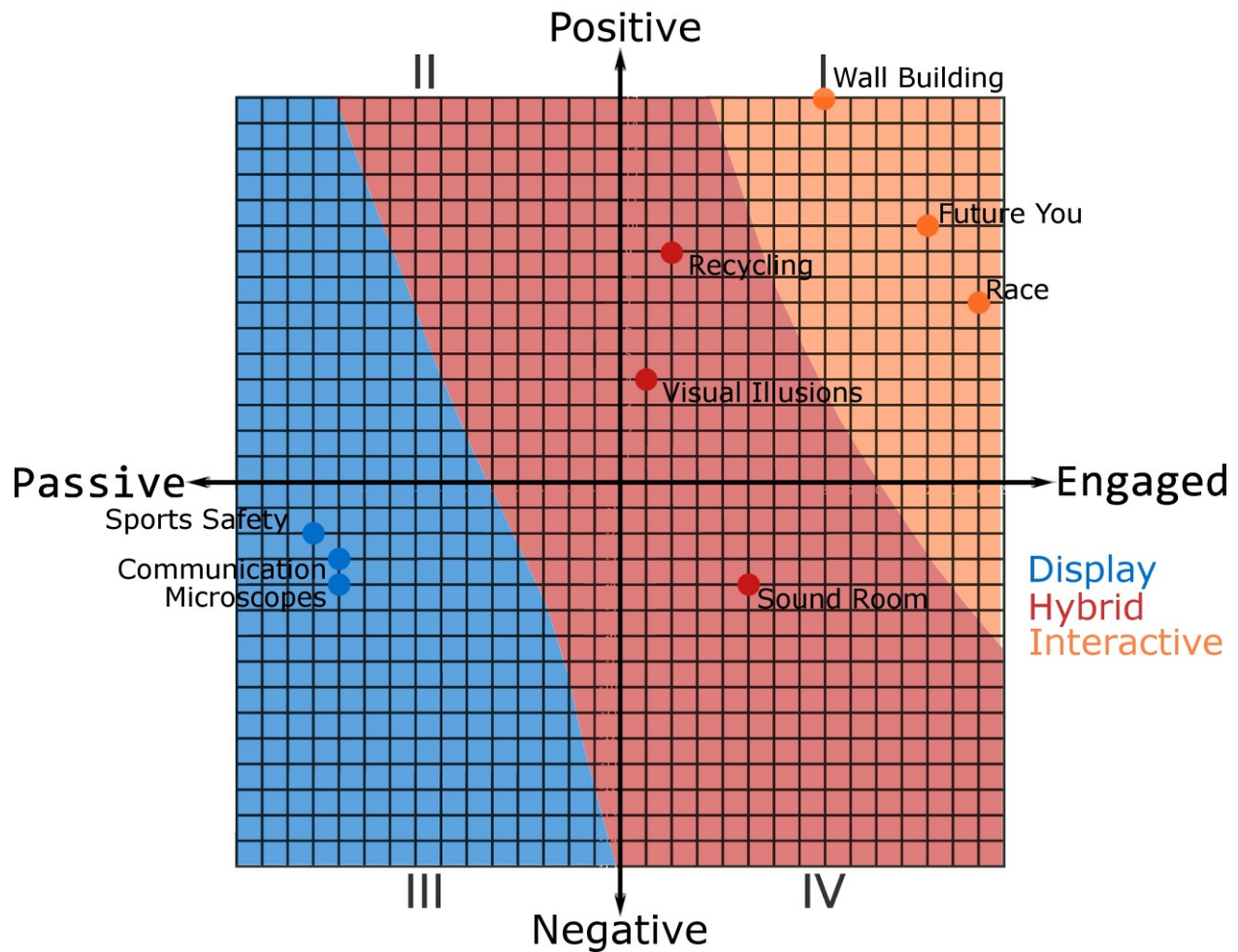


Figure 12: Engagement vs. Favorability Scatterplot

4.2.2 Little reading occurs with children, because they are more excited to interact.

Throughout the observation process while tracking, we noticed that children were not reading any of the displays. Based on the data collected, there were a total of 253 opportunities to read throughout Scienceworks. On average, only 5.8 of these possible opportunities were taken advantage of. Thus, there is significantly less reading going on than is possible. Table 5, shown at the beginning of this section, shows all the interactions in the first column, and the number of times each was performed in the columns labeled with the various track numbers. As one can observe, the 'read' interaction was one of the least frequent, especially given the amount of placards to be read throughout the museum. Other interaction opportunities, when compared to reading, are thus more appealing to children.

4.2.3 There is minimal correlation between age and engagement score.

We analyzed our engagement data by age to understand whether age had an effect on engagement score. Figure 13 shows age versus engagement score, with age on the horizontal axis and engagement score on the vertical axis. A line of best fit was drawn based on the data points.

Few data points fit on the line, indicating minimal correlation; therefore, age has little impact on engagement at Scienceworks. This could be due to the fact that certain areas of Scienceworks target certain age groups, meaning that a child may interact more with an exhibit geared toward his/her demographic. This evens out the interactivity since not all visitors will visit all exhibitions.

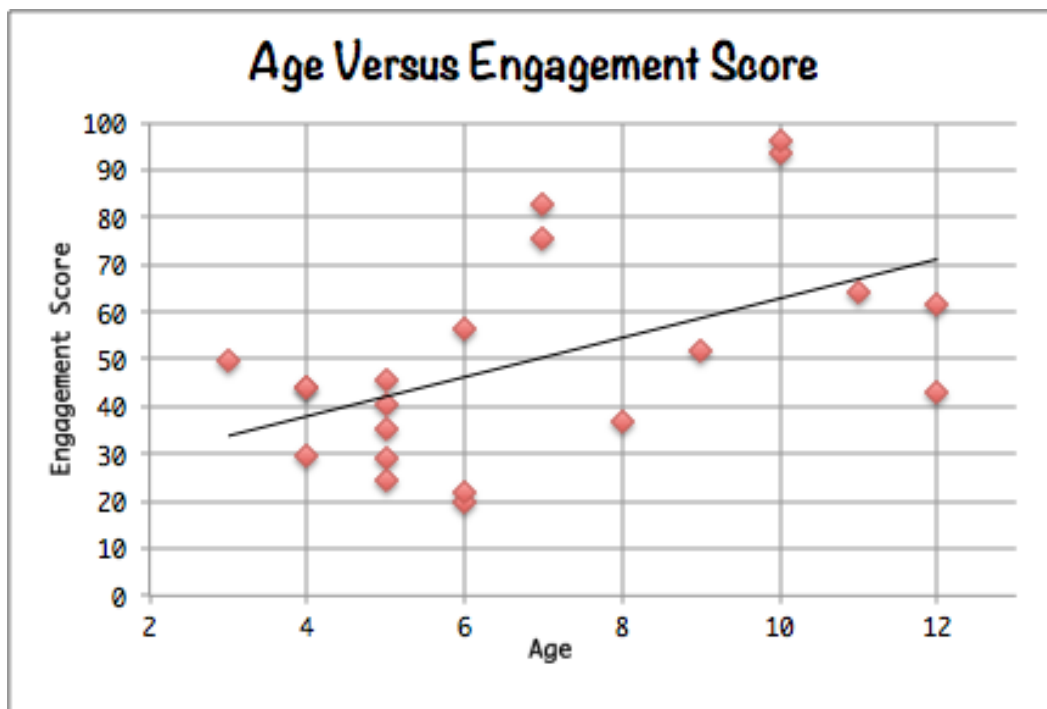


Figure 13: Age vs. Engagement Score Correlation

4.2.4 Females receive slightly higher engagement scores than males.

Figure 14 is a bar chart depicting ranges of engagement scores for males and females. Many more males score at the lower end of the engagement ranges, whereas females tend to score towards the higher end. This can also be seen in the averages of the scores. Males average a 48.7 engagement score while females average a 51. The two highest scorers were males, but they are outliers, since most males scored on the lower end of the spectrum. Generally, the graph featured in Figure 14 shows that females interacted with the exhibits in more ways than males. This could be due to the fact that some museum exhibits potentially appeal more to one gender than the other. Another consideration here is outside factors. According to Doctor Martin Kaiser, a female's brain can mature as early as age ten, but for boys it takes until sometime between the ages of fifteen and twenty (Kaiser, 2013). Our observations that Scienceworks' exhibits are engaging females more than males could indicate an increased interest in STEM, which could be a positive sign for more women entering STEM fields in the future.

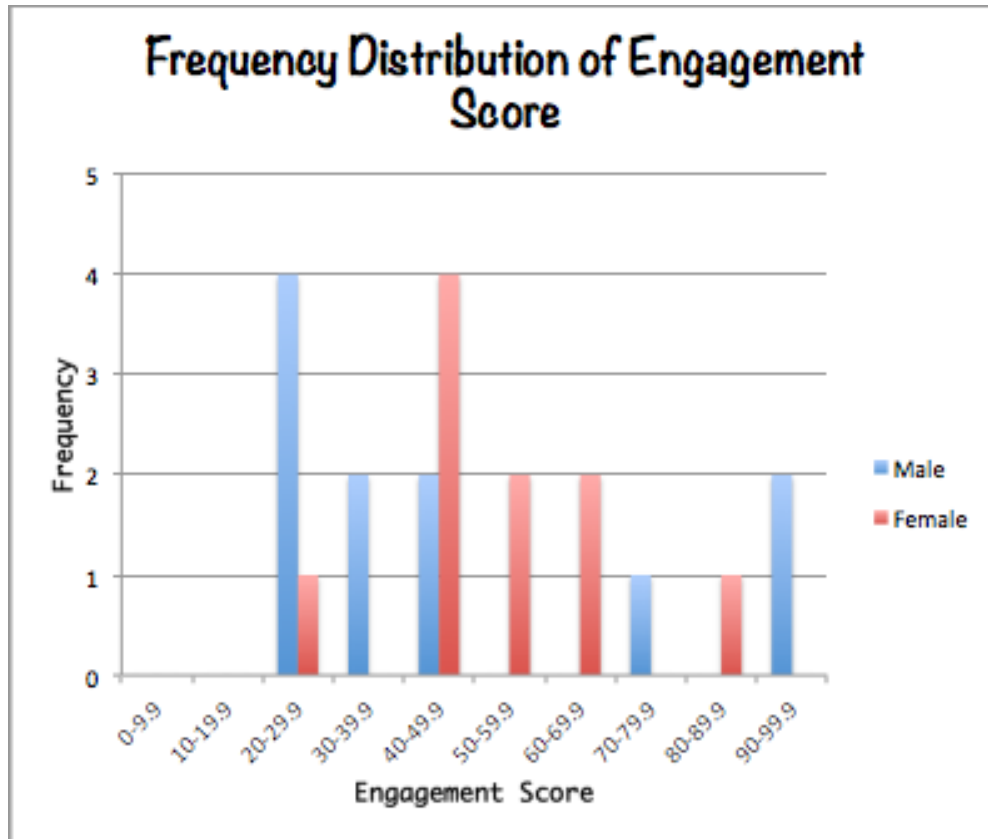


Figure 14: Gender vs. Engagement Score Comparison

4.2.5 A higher number of stops at exhibits correlates to a higher engagement score.

Figure 15 shows that as the number of stops a visitor makes increases, so does the engagement score. Since most of the data points are on or are very close to the line of best fit, there is a strong correlation between these two metrics. An increased number of stops increases the number of opportunities for interactions at Scienceworks; thus, it ultimately leads to a higher engagement score or potential for learning. Visitors with a higher number of stops spent more time at exhibits likely indicating that they took advantage of more learning opportunities.

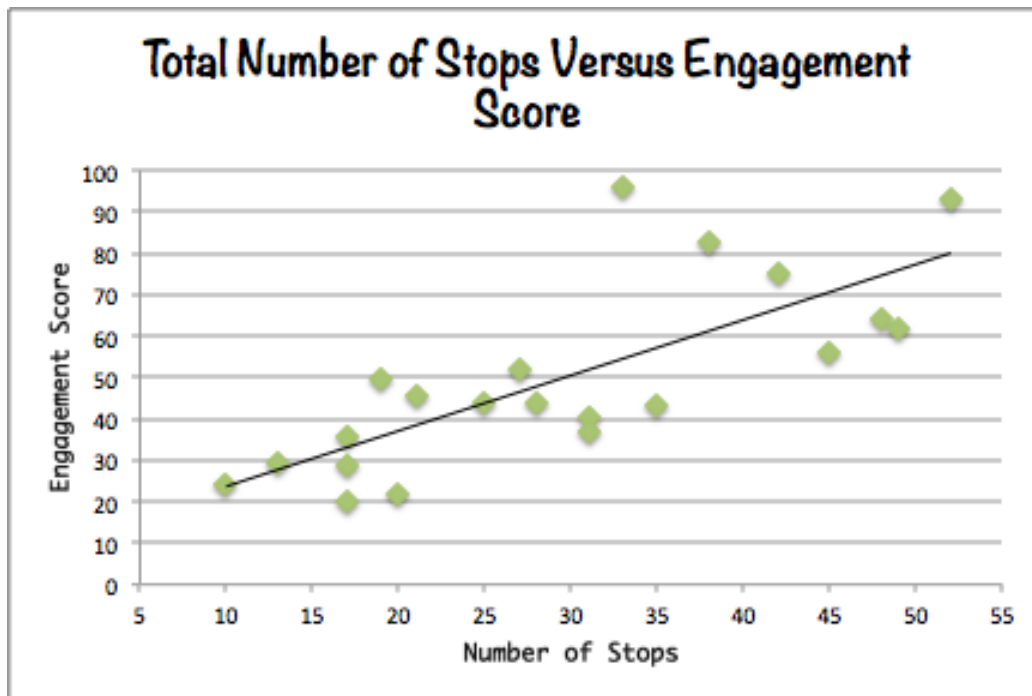


Figure 15: Stops vs. Engagement Score Correlation

4.3 Findings Involving Exhibits and Exhibitions

The next area we wanted to look into during our stay at Scienceworks was how visitors responded to the exhibits and exhibitions. As a reminder an exhibit is a specific subsection of a museum that focuses on one topic in a broader subject of information. An exhibition is a collection of exhibits all centered around one theme. Much of the data collected about exhibits and exhibitions is purely observation based. When we were tracking visitors we would focus on the visitor we were tracking, but also try to observe the area we were in as a whole. It was through this that we were able to see patterns develop. It is these patterns that are discussed in this section. For a more detailed description of these observations see Appendix E for the commentary on each exhibit.

4.3.1 The Money Exhibit, Future Visions, and the Rotundas of Think Ahead are rarely explored likely due to their location in Scienceworks.

The Money Exhibit and Future Visions exhibits are in the top right hand corner of Figure 16 (labeled 2 and 4), while the Rotundas are on the bottom (labeled 18 and 19). This figure is a congestion heat map of the first floor at Scienceworks, showing the amount of traffic at different areas of the museum. This was created by overlaying all of the drawings of the twenty-one tracks on top of each other. The heat color is determined by the number of tracks that went to that area. The scale on the side shows that the dark red areas represent areas where almost all of the tracks went, where dark blue areas represent areas where few to none of the tracks went. The areas surrounding the Money Exhibit, Future Visions and the Rotunda exhibits are on the cool to cold

end of the heat spectrum indicating fewer visitations. Certain areas of the museum, such as these four exhibits, are not explored as often because they are tucked away in corners and cannot be clearly seen from other areas of Scienceworks.

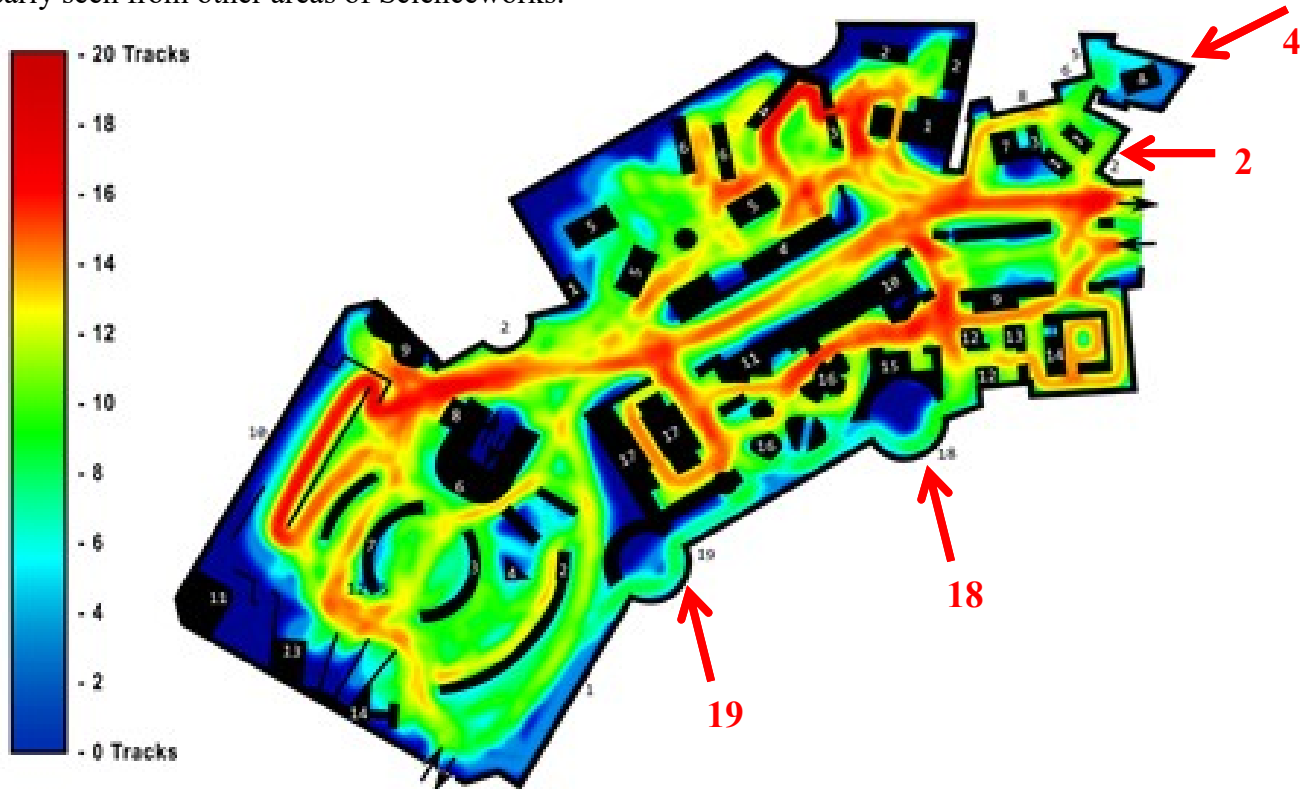


Figure 16: Tracking Heat Map First Floor with Arrows Pointing to the 3D Printer (#4), the Money Display (#2), and the Rotundas (#18 & #19)

4.3.2 The Communication Exhibit of Think Ahead does not get visited by a majority of the tracks.

Our analysis shows that only 24% (5 of the 21) of the tracked visitors stopped here. Some possible reasons for this oversight could be the design, which is a tunnel shape, or the large amount of placards with few possible interactions. When looking at this exhibit from the front, none of the displays are visible due to the layout. In addition, the signage telling that it is the Communication Exhibit is on the side of the wall. Visitors walking in would have to turn their head when in front of the sign to see it. A lot of visitors use the center of this exhibit as a walkway that can be seen in the zoomed in section of the heat map pictured below in Figure 17. This may look like a highly trafficked area if you just look at the map but in reality it is not an area of high interactivity.

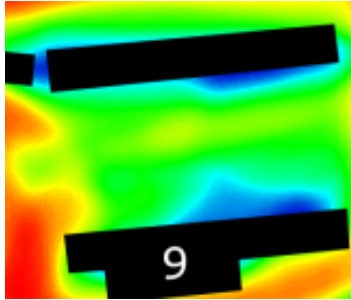


Figure 17: Heat Map of Communication Exhibit (Between black lines)

4.3.3 Children “jump the gun” at the Race exhibit.

Almost every single child who runs the race at Scienceworks jumps the gun; this was seen in our tracks and general observations. The race exhibit is set up so that a child can race Cathy Freeman, the Australian running legend. A visitor must push a button to start the race, wait for the signal, and then run down the track. They can then look at their time compared to Cathy Freeman’s on a board above the finish line. Many children go before the start up sequence is complete and only one child we were tracking didn’t start racing early. He ran the race several times, but only started at the right time for about a quarter of his runs. When the button to start the race is pushed, the announcer will say “on your marks, set, *delay* *gun firing sound*.” This delay throws children off and some end up three quarters of the way down the track before the gun sounds. While the gun sounding is appropriate for a real life setting as that is how track and cross-country races begin, a child does not know that and does not grasp the concept. It would be much better to say “on your marks, set, go.” With the current setting, the accuracy of the race times are compromised and the idea of running against Cathy Freeman is lost. It just becomes a place for children to run which is not the point of exhibit. The exhibit could be designed differently to ensure that visitors grasp the idea of running against a world-class runner: the race start up sequence could be more explicit or the delay can be eliminated.

4.3.4 The exhibits that best held the attention of children were all interactive based.

When we were preparing for our study, we took the time to carefully choose nine specific exhibits. As mentioned previously, three of these exhibits were from Nitty Gritty Super City, three from Think Ahead, and three from Sportworks. One exhibit from each exhibition was interactive based, one was display based, and one was a hybrid of both types. We then went to each of these exhibits and timed ourselves completing all possible interactions. From there, we averaged all of our times together to create an estimated design time. These estimated design times are visible in the middle column of Table 9 below.

Nitty Gritty	Design (min)	Average Use (min)
Wall Building	5	12.3
Recycling	4	1.6
Microscopes	5	0.5
Think Ahead		
AR/robot	2	7.2
Sound room	2	1.7
Communication	13	0.6
Sportswork		
Race	1	3.3
Visual Illusion Wall	9	1.8
Sports Safety	2	0.1

Table 9: Holding Times

After we were done collecting data, we averaged out the amount of time all of our tracks spent at each of these chosen exhibits. These averages can be seen in the last column of Table 9. For all of the interactive exhibits (highlighted in orange) the average time spent is well over the estimated design time. Both the display (highlighted in blue) and the hybrid (highlighted in red) exhibits had times well below the estimated design time. This indicates that these interactive exhibits are better for holding the attention of the main target demographic of the museum, the children. The data may be slightly skewed since at both the Future You and Race exhibits children may have to wait in line for a turn. However, if the children are willing to wait in line for a turn, then it must mean that some aspect of the exhibit is appealing to them.

4.3.5 Interactive exhibits have the highest utilization with 62.1% of their possible interactions being completed on average.

For an exhibit to be used to its full potential, all of the possible interactions need to be completed. Table 10 shows nine exhibits, three from Nitty Gritty Super City (NGC), three from Think Ahead (THA), and three from Sportsworks (SPW). Of the three exhibits from each exhibition, one is a display-type exhibit, one is an interactive exhibit, and one is half-display/half-interactive or a hybrid of the interactive and display-type exhibits. These exhibits were chosen because we felt they were representative of both the exhibit class they fit into and the exhibition they were a part of. In Table 10, each of the types of exhibits are color-coded, with orange representing interactive exhibits, red representing hybrid, and blue representing display. The column named “Possible” shows the total number of possible interactions at each of the exhibits. A percentage was computed by taking the interactions a visitor had with an exhibit and dividing it

by the total amount of possible interactions. The percentages were then averaged across the twenty-one tracks completed. These averages indicate whether each exhibit is being used to its full potential or not. In other words, how much of the interactivity experience is not being completed by the visitor. Looking at our sample of exhibits and their percentages, our utilization data indicates that many exhibits are not being used to their full potential. The data also shows that interactive exhibits have the highest utilization percentages, but even some of those high percentages are not the best they could be. The exhibit may be expecting too much of the visitor, or it may have extraneous interactive possibilities that are not needed. These findings can be used in the future to help design exhibits so that these percentages are in the 60-80% range. This could be a good target range for future exhibit design.

Percent Utilization		
Exhibit	Possible	Average
Nitty Gritty Super City: Microscopes	14	6.4%
Nitty Gritty Super City: Wall Building	38	43.5%
Nitty Gritty Super City: Recycling	34	9.3%
Sportsworld: Visual Illusions	53	6.9%
Sportsworld: Sports Safety	15	4.8%
Sportsworld: Race	16	76.4%
Think Ahead: Communication	22	6.6%
Think Ahead: Future You	18	66.4%
Think Ahead: Sound Room	21	19.1%

Display: ■

Hybrid: ■

Interactive: ■

Table 10: Utilization of Sampled Exhibits

4.3.6 Younger children tend to spend most of their exhibit visiting time at Alice's Wonderland and Nitty Gritty Super City.

Since these exhibitions are designed for a younger audience, this is what we expected to learn. The target demographic for these two exhibitions is children between the ages of three and eight. For tracks involving children in this age range, 67% of the children spent a majority (more than 50%) of their exhibit time at Alice's Wonderland and/or Nitty Gritty Super City. This is also supported through visual observation as we have seen all of the younger visitors spending significant time in these areas. The data as well as our observations support that the intended target demographic is being reached.

4.4 Findings Involving the Whole Museum

After observing trends and patterns in exhibits and exhibitions, we looked at patterns seen in the museum as a whole. These patterns involve everything from visitor traffic patterns to what affects visitor engagement. All of these findings were based on tracking observations and data analysis.

4.4.1 Areas of high interactivity cause high congestion.

As observed in Figure 18, areas of high congestion are often indicators of high interactivity exhibits. The map on the right side of Figure 18 shows the amount of visitor traffic, with red representing high visitation and blue representing low to no visitation. The map on the left side of Figure 18 shows the interactivity at exhibits, with red representing high interactivity and blue representing low interactivity. It can be seen that the areas of high congestion are generally next to highly interactive exhibits, indicating that the interactivity of an area does indeed influence how congested an area gets. The Alice's Wonderland exhibition in the top middle of both maps has orange to red coloring for both congestion and interactivity. This is also true for sections of Think Ahead (lower right hand corner) and Sportworks (left hand side near the stairs). The interactive heat map and congestion heat map show that the areas of greater interactivity also have a greater amount of congestion.

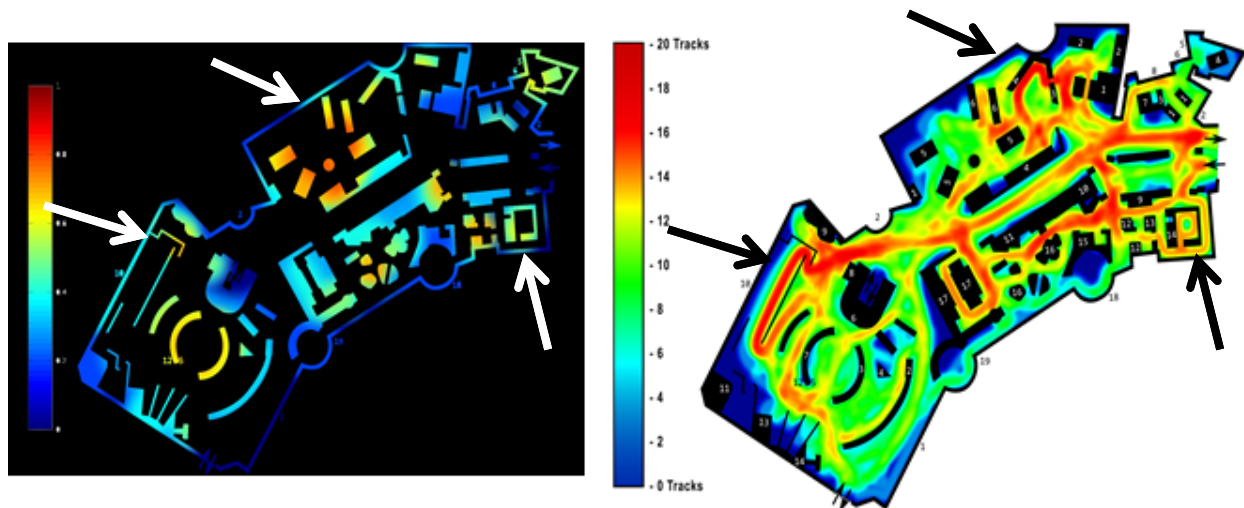


Figure 18: Interactivity Map vs. Heat Map First Floor

4.4.2 New museum visitors tend to explore all of Scienceworks, while members and repeat visitors go straight to certain exhibits.

Members and first time visitors can usually be differentiated by which entrance they use, as there is a members only entrance. Most new visitors take a map whereas nearly all member families do not take a map. Since member families have likely been to Scienceworks several times, they are less likely to interact with all the museum spaces because they already have their favorites and least favorites. Knowing the layout of Scienceworks and planning to visit certain exhibits

influences the members to only go to their favorite exhibits and spend minimal time at others. For instance, in one of our tracks with a museum member, the visitor took his children directly from the entrance to the Future You exhibit. In another track in which we knew the group was a member, we observed that the group spent the majority of their time at the Wall Building exhibit. Visitors who we knew to be new visitors did not spend long periods of time at exhibits because they wanted to be able to see all of Scienceworks. Many of our shorter tracks were of museum members, which indicates that they did not feel the need to look through the whole museum, and only went to the parts they wanted to visit. All of this evidence points to the idea that new visitors explore all of Scienceworks while members and repeat visitors only visit certain exhibits.

4.4.3 Proper signage and explicit instruction are needed to provide general awareness of exhibits and increase usage.

We observed that visitors gravitate toward exhibit doors, tunnels, or entrances when presented with signage in the area as seen at Alice's Wonderland. Visitors are drawn to the colorful sign and several will even take a picture with it. If there were no signs and a blank wall instead, people would likely not be immediately attracted to it. Exhibits in the middle of the museum or in wide-open areas receive traffic due to their location, ex. Race. Tucked away areas with increased signage have increased travel compared to tucked away areas without signage. Several areas could benefit from improved signage. One such area is a corner of the museum that houses the 3D printer, which hardly receives any attention except for the days that an announcement is made to inform visitors about its existence. The 3D printer's lack of visitation is supported by the congestion heat map pictured in Figure 19. It is in the upper right hand corner, labeled number 4. Another thing that could help the 3D printer's lack of visitation is to have more announcements informing visitors of ongoing presentations that show how the printer works. When announcements were made on the weekends, visitor traffic increased significantly.



Figure 19: Tracking Heat Map First Floor with Arrows Pointing to the 3D Printer (Exhibit 4)

Several exhibits could benefit from more explicit and eye-catching instructions to increase their usage. These exhibits include the Lego City and Excavator in Nitty Gritty Super City. In the case of Lego City, there is a game of ‘Can you find...’ written on the top and bottom of the exhibit, but the light orange text blends into the orange background. This text does not catch the visitor’s eye and it is not in their direct field of vision. In our twenty-one tracks that were completed, not a single visitor noticed the questions on the side of the exhibit asking if they could find scenarios such as ‘someone flying a kite.’ Similarly, the Excavator has instructions written on a placard explaining how to use the levers; however, it does not explain that there is a button placed a few feet away that must be pressed for the Excavator to work. If not pushed, the hydraulic pump will remain off, rendering the machine useless. This lack of instruction confuses children and deters them from playing with the Excavator because they think it is broken.

Another final example where instruction would be helpful is at the Future City exhibit. This exhibit centers around the visitor building a virtual city using a computerized surface and plastic blocks with visual codes printed on them. Each game has a different objective that needs to be achieved; the visitor must rotate the blocks to change them in order to meet the goals for the following categories: environment, people, and money. This is not stated in a highly visible manner anywhere, so children are left to move blocks around and do nothing else because they do not understand this important game mechanic.

4.4.4 An average track can be obtained from the data collected.

This average track provides a single path that is representative of all of the tracks combined. It is obtained by taking all of the digitized tracks, overlaying them, and seeing which path would be most representative for the total number of tracks. The result is the most likely, or most common path that a visitor would take through the museum. Figure 20 depicts the average track as a blue

line on the first floor of Scienceworks while Figure 21 depicts the average track as a blue line on the second floor; the series of red lines in both figures represents the overlay of all twenty-one tracks. These paths could influence suggestions pertaining to signage, exhibit orientation, and give rise to new evaluation techniques to be used in the Scienceworks of the Future initiative.

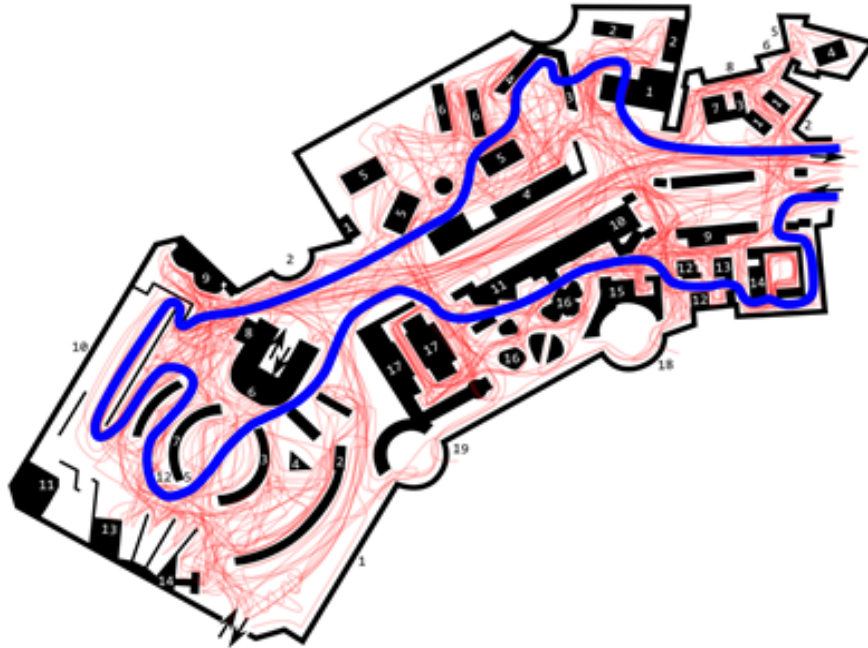


Figure 20: Average Track First Floor

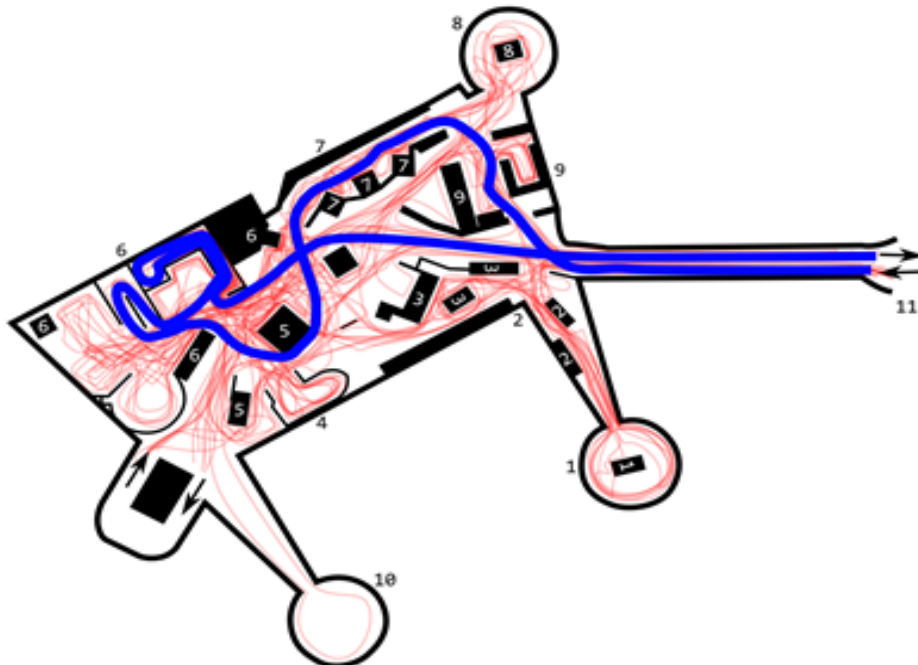


Figure 21: Average Track Second Floor

5. Recommendations and Conclusions

This chapter presents recommendations for Scienceworks to improve their exhibit design and future tracking studies. We based our recommendations on background research, whole site visitor tracking, visitor behavior observation and surveys of families as they completed their visit at Scienceworks. Our recommendations to Scienceworks are:

1. Consider including more interactive elements in exhibits, as interactive elements are preferred by visiting families.
2. Attract more visitors to unexplored areas by 1) improving signage/highlighted maps 2) making announcements about exhibits in these areas and 3) including interactive events in unexplored areas
3. Provide more explicit instructions readily available for visitors to read before starting an activity, as some exhibits are not being used as intended.
4. Daily environmental factors such as day of the week and number of visiting school groups should be taken into account in future tracking studies.
5. Consider completing more weekend whole of site visitor tracks as the majority of this research completed tracks that were on weekdays.

5.1 Recommendations

Recommendation #1: We recommend that Scienceworks include more interactive elements in their exhibits.

Fully interactive exhibits are preferred over the traditional display-type exhibits based on background research and our tracking and survey data. Through background research, we determined that interactive exhibits offer a more engaging, and educational, experience to visitors by offering specific elements such as buttons, videos, etc. These elements help to engage the visitor, which can lead to a higher number of learning opportunities. In order to confirm this research finding, our team observed visitor behavior and determined that families visited more interactive exhibits and stayed longer at interactive exhibits than display or hybrid exhibits. This is likely due to interactive exhibits having elements that visitors perceive as attractive, such as large touch screens and music.

Our tracking data also confirmed that interactive exhibits were preferred. *Tracking data (Finding #13) demonstrated that a higher percentage of possible interactions were completed by the visitors at interactive exhibits than at display or hybrid exhibits.* Once visitors stopped at an exhibit, they performed various interactions. As interactive exhibits offered more opportunities than display and hybrid type exhibits, visitors took advantage of these opportunities to engage with the spaces and spent more time at these exhibits. *Visitors spent less time at the display and hybrid exhibits, as they were not exposed to as many interactive opportunities, as discussed in Finding #12. Little reading occurs with children because they were more excited to interact (Finding #5);*

therefore, the display and hybrid exhibits did not hold visitors for as much time as the interactive exhibits. Unfortunately, we were not able to get close enough to visitors while observing to hear what they were saying, but through post-visit surveys we were able to obtain the visitors' perspective on the effectiveness and popularity of the different types of exhibits.

As discussed in Finding #4, *interactive exhibits received a higher number of positive survey responses than display and hybrid exhibits*. The majority of the visitors selected interactive exhibits as their favorite as well as most educational exhibits. Visitors rarely selected interactive exhibits as their least favorite or least educational.

In conclusion, our findings demonstrate that *visitors are more attracted to interactive exhibits*. As Scienceworks looks to improve their exhibit design for the future, they should consider implementing a greater number of interactive elements in exhibits throughout the museum.

Recommendation #2: We recommend that Scienceworks increase visitor awareness of unexplored areas.

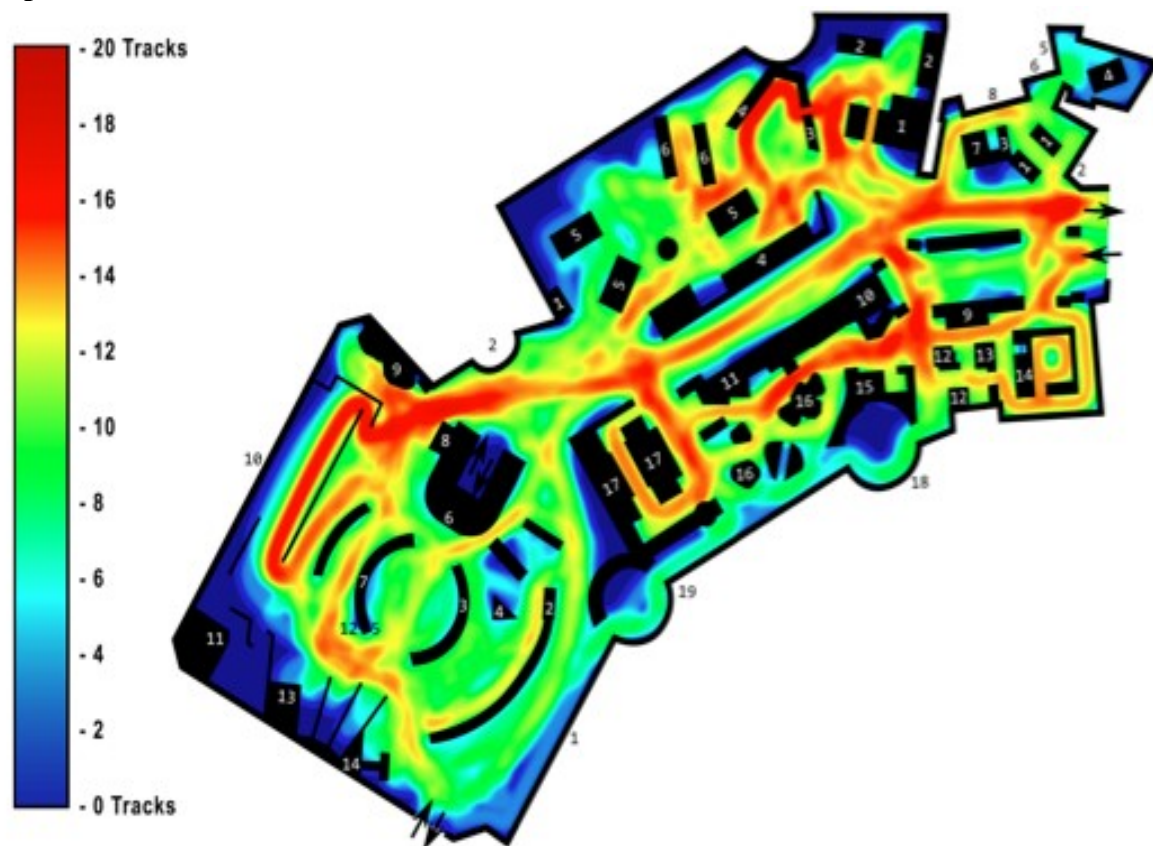
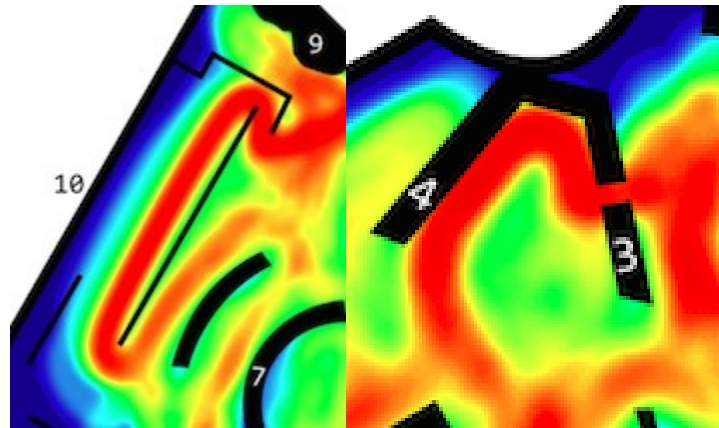


Figure 22: Tracking Heat Map

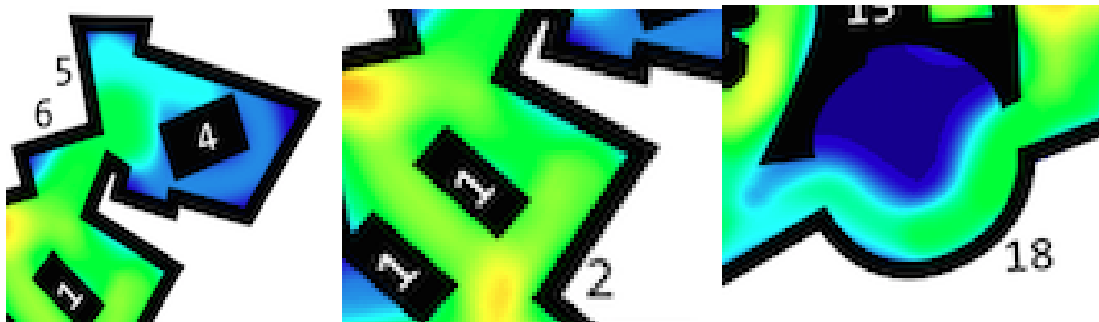
There are several areas of Scienceworks that are overlooked. As discussed in Finding #17, more signage, making announcements, highlighting areas on maps, or hosting interactive events in less visited areas could help increase visitor flow to these areas. As can be seen in Figure 22 above, there are several areas of the map on the first floor with high visitation and other areas with

low to no visitation. Popular exhibits and main pathways are dark red, while corners are dark to light blue. Location of the exhibit and/or the signage of the exhibit tend to be what distinguishes popular areas from less popular areas.



Race (Between 9 and 10) Alice Room (Between 3 and 4)

Figure 23: Examples of Highly Explored Areas



Future Visions (#4)

Money Display (#2)

Biotechnology Room (Rotunda (#18))

Figure 24: Examples of Less Explored Areas of Think Ahead

For example, as can be seen in Figure 23 above, *the Race and Alice Room exhibits are highly visited* as the pathways are dark red (Finding #17). Sixteen or more of the twenty-one visitors we tracked visited these exhibits. Both of these exhibits are in a wide-open area and can be seen from various locations of the museum. They also have large, bright, colorful signs to draw visitor's attention. *Several areas of Think Ahead, such as the Future Visions, Money Display, and Biotechnology Room* in Figure 24, *are less visited* (Finding #9). The Future Visions exhibit houses a 3D printer and the Biotechnology rotunda has a collection of biotechnological equipment including a DaVinci surgical robot, but only four to eight visitors we tracked went to these areas. Our observations indicate that these exhibits are not being explored due to the lack of general awareness that they exist. By making people more aware of the exhibits they can't initially see, it will allow for a greater learning experience, as visitors will be more apt to visit those exhibits. Our findings are further explained in Section 4.3. Knowing which areas are not being explored will be helpful to Scienceworks as it redevelops its exhibition spaces.

Recommendation #3: We recommend that Scienceworks have more explicit instructions readily available for visitors to read before starting an activity.

*Based on our observational research, the Race and Future City exhibits of Think Ahead, and the Excavator and Lego City of Nitty Gritty Super City are not being used as intended by Scienceworks. As described in Section 4.3, many children do not understand the concept of the start of the race exhibit. The race begins with the announcer saying “On your marks, set, *short delay* *gun fires*,” just like how a track and field race begins. Many children go before the gun sounds. The educational message of competing against Cathy Freeman, a world-class runner, is lost since the children beat her every time. Race timing becomes inaccurate and children who do wait for the gun to go off become frustrated with those who “cheat.” A clear sign such as “Go when the gun sounds,” or colored lights above the finish line that light from red to green along with the announcer’s voice could be more effective and help visitors understand how to use this exhibit properly. Another possibility to improve this exhibit would be changing what the announcer says to “on your marks, set, go.” This is a clear instruction that children of all ages will understand.*

As discussed in Finding #17, several exhibits would benefit from clearer instructions and signage. Fifteen of the twenty-one children we tracked were led through the museum by adults. Since adults can read, more signage will increase awareness of these exhibits and lead to more visitation. At the Future City exhibit a visitor builds a virtual city using plastic blocks with the objective to achieve goals in the following three categories: environment, people, and money. These instructions are not stated in a highly visible manner, so children randomly move blocks, get bored, and leave shortly after. With the instructions visibly stated, people would know what to do with the blocks to achieve the game’s goal and therefore stay more engaged. For the Excavator exhibit, the button begin operating the machine is located several feet away. The sign informing visitors about this button is not readily noticeable. Many visitors will try to move the levers and when the machine doesn’t move, they leave assuming it is broken. A sign should be placed where the levers are located on the machine in order to inform visitors how to turn the Excavator on. A final example that would benefit from clearer signage is Lego City. Lego City has a game of ‘Can you find...’ written on the top and bottom of the exhibit. This is a fun aspect of the exhibit that gets overlooked. If the color of the text was different and didn’t blend into the background, people would be introduced to an additional feature that the exhibit has to offer.

In conclusion, by providing explicit instructions and clear signs, exhibits can be used to their full potential with little chance of them being misused. While a visitor may still find joy in an exhibit without seeing instructions, educational messages may be missed.

Recommendation 4: We recommend that daily environmental factors should be taken into account in future tracking studies.

During visitor observation, we noticed that *a couple of factors affected visitor behavior: day of the week and number of school groups*. As discussed in Finding #3, the day of the week and the presence of school groups influence how families move throughout the museum. During the week there are several school groups present in the museum, leading to a congested environment. Through observation we noticed families move from exhibits that had large school groups to less congested areas. Children in families did not have as many chances to interact with some of the exhibits due to long lines. Conversely, weekends presented a more relaxed environment for visitors to explore the museum. We observed that the less congested environment led to children taking more time at exhibits and exploring more areas. We acknowledged that visitors might have been able to spend more time at the museum on weekends due to having fewer commitments; however, it was evident that children interacted more on the weekends than on the weekdays.

In conclusion, *visitor behavior is influenced by daily environmental circumstances*. The presence of school groups and day of the week affect the congestion of the museum spaces and subsequently affect visitor interactivity.

Recommendation 5: We recommend that Scienceworks complete more weekend whole of site visitor tracks.

We completed twenty-one whole of site visitor tracks, including over sixty hours of observation and tracking of children. While we have been able to draw several conclusions from our data, a stronger sample size would further validate these conclusions. In past studies, Museum Victoria has completed forty tracks; however, we have spent approximately the same amount of hours physically tracking visitors (Finding #1). *We tracked children ages three through twelve, and found that there was no correlation between age and engagement score* (Finding #6). Engagement score is a metric we developed to quantify a visitor's level of interaction. Additionally, we ensured that the gender ratio was even, and found that *females had slightly higher engagement scores than males* (Finding #7). Lastly, we found that *a higher engagement score correlated with more stops being made within the exhibitions* (Finding #8). We recommend that Scienceworks complete more tracks, with the goal of an equal split between weekday and weekend data. Of our twenty-one tracks, only four were completed on the weekend due to time constraints. *There was a significant difference between weekend and weekday data, with weekend tracks having higher engagement scores and longer visits* (Finding #3). The average age of the weekend tracks compared to the weekday ones was higher because the older age group was underrepresented, since weekday tracks were usually younger children not in school. In order to get a wider distribution of ages, we tracked older children on the weekend. As Finding #2 suggests, *our tracking and observational methods are reproducible*; therefore, Scienceworks will be able to accurately repeat our study.

5.2 Conclusion

The goal of this project was to observe visitors in Scienceworks of Museum Victoria, evaluate how they were currently using the exhibits, and provide recommendations on how the exhibits can be more meaningful and engaging. Through our background research and experience with visitor tracking at Scienceworks, our team was able to successfully evaluate the current usage of various exhibits and determine possible improvements. We also provided Scienceworks with recommendations regarding improvements to their exhibit design and future tracking studies. In addition, our team has supplied Scienceworks with an assessment of visitor behavior and an evaluation of current exhibit usage. Scienceworks will be able to use the information presented in this report to improve their exhibit design for the future.

References

- About Us. (n.d.). Retrieved September 10, 2015, from Museum Victoria: Scienceworks website:
<https://museumvictoria.com.au/scienceworks/about-us/>
- Allen, G. C. (2015, November 10). [E-mail interview by the author].
- Black, G. (2005). *The engaging museum: Developing museums for visitor involvement*. London: Routledge.
https://books.google.com/books?id=cXTiEWMQxMEC&pg=PA9&lpg=PA9&dq=first+museum+visitor+studies&source=bl&ots=arJsSehKE1&sig=vD4YMLx_wjOgaXIZyyTVQm9WLLQ&hl=en&sa=X&ved=0CB8Q6AEwAGoVChMI-P2dhpTrxwIVzDQ-Ch3lDwTz#v=onepage&q=first%20museum%20visitor%20studies&f=false
- Borreli, L. (n.d.). Human Attention Span Shortens To 8 Seconds Due to Digital Technology: 3 Ways to Stay Focused. Retrieved September 15, 2015, from Medical Daily website:
<http://www.medicaldaily.com/human-attention-span-shortens-8-seconds-due-digital-technology-3-ways-stay-focused-333474>
- Catlin-Legutko, C., & Klingler, S. (Eds.). (2012). *The Small Museum Toolkit* (Vol. 4). Lanham, US: Rowman & Littlefield.
- Caulton, T. (1998). *Hands-On Exhibitions: Managing Interactive Museums and Science Centres*. Routledge. Ebook: <http://site.ebrary.com/lib/wpi/reader.action?docID=10016987>
- Chang, T.-J. (2008). *Effects of Design Features on Visitors' Behavior in a Museum Setting*. University of Kansas.
- Chouinard, M. M. (2007). Children's questions: a mechanism for cognitive development. *National Center for Biotechnology Information*, 72(1), 1-112. Retrieved from
<http://www.ncbi.nlm.nih.gov/pubmed/17394580>
- Continuous and Comprehensive Evaluation [Pamphlet]. (2013). New Delhi, IN: Central Bureau of Secondary Education.
- Diamond, J., Luke, J. J., & Uttal, D. H. (2009). *Practical Evaluation Guide: Tool for Museums and Other Informal Educational Settings* (2nd ed.). Lanham: Rowman & LittleField.

- Dixon, M. (2011, December 20). Why have museums forgotten the teens? Retrieved November 9, 2015, from The Guardian website: <http://www.theguardian.com/culture-professionals-network/culture-professionals-blog/2011/dec/19/museums-teenagers-engagement>
- Donald, J. (1991). The Measurement of Learning in the Museum. *Canadian Journal of Education*, 16(3), 371-382. doi:10.2307/1494885
- Eliot, S., & Zilberman, M. (n.d.). Recent Institutional Awards. Retrieved November 30, 2015, from <http://www.exploratorium.edu/press-office/recent-institutional-awards>
- Escuer, P., Mateo, A., McConnell, C., Schutes, J. (2014) Refining Visitor Tracking for Museum Victoria (Undergraduate Interactive Qualifying Project No. E-project-050614-203635). Retrieved from: Worcester Polytechnic Institute Electronic Projects Collection: https://www.wpi.edu/Pubs/E-project/Available/E-project-050614-203635/unrestricted/Museum_Final_Report_7May14.pdf
- Exhibit vs. exhibition. (2014). Retrieved December 5, 2015, from <http://grammarist.com/usage/exhibit-exhibition/>
- Falk, J. H., & Dierking, L. D. (1992). The Museum Experience. Left Coast Press. https://books.google.com/books?id=Hd9l6gt6aJ0C&pg=PA55&dq=visitor+behavior+at+museums&hl=en&sa=X&ved=0CC8Q6AEwAWoVChMI763m4_3sxwIVw1Y-ChlGngCu#v=onepage&q=visitor%20behavior%20at%20museums&f=false
- Gilman, B. I. (1916). Museum Fatigue. *The Scientific Monthly*, 2(1), 62-74. Retrieved from JSTOR database. link: http://www.jstor.org/stable/6127?seq=1#page_scan_tab_contents
- Gorman, A. (2008). *Museum Education Assessment: A Survey of Practitioners in Florida Art Museums*. Florida State University College of the Visual Arts, Theatre, & Dance.
- Griffin, J. M., Kelly, L., Savage, G., & Hatherly, J. (2005). Museums actively researching visitors experiences and learning (MARVEL): a methodological study. <https://opus.lib.uts.edu.au/research/handle/10453/6061>
- Hooton, C. (2015, May 13). Our attention span is now less than that of a goldfish, Microsoft study finds. *The Independent*. Retrieved from <http://www.independent.co.uk/news/science/our-attention-span-is-now-less-than-that-of-a-goldfish-microsoft-study-finds-10247553.html>
- Jant, E. A., Haden, C. A., Uttal, D. H. and Babcock, E. (2014), Conversation and Object Manipulation Influence Children's Learning in a Museum. *Child Development*, 85: 2029–2045. doi: 10.1111/cdev.12252

- Korn, R. (1994). Studying your visitors: Where to begin. *History News*, 49(2), 23-26.
<http://courses.washington.edu/mus588/Winter2008/documents/studying.your.visitors.pdf>
- Lim, S., Han, C. E., Uhlhaas, P. J., & Kaiser, M. (2013). Preferential Detachment During Human Brain Development: Age- and Sex-Specific Structural Connectivity in Diffusion Tensor Imaging (DTI) Data. *Oxford Journals: Cerebral Cortex*. Retrieved from
<http://cercor.oxfordjournals.org/content/25/6/1477.short>
- Meehan, C., & Veis, N. (2015, October 28). [Personal interview by the author].
- Melton, A. W. (1972). Visitor behavior in museums: Some early research in environmental design. *Human Factors*, 14(5), 393-403.
- Miaoulis, I. (2011, December 7). Museums Key to STEM Success. *USNews & World Reports*. Retrieved from <http://www.usnews.com/news/blogs/stem-education/2011/12/07/museums-key-to-stem-success>
- Pekarik, A., Button, K., Doering, Z., Sharbaugh, A., & Sutton, J. (2002, May). *Developing Interactive Exhibitions at the Smithsonian*.
<http://www.si.edu/Content/opanda/docs/Rpts2002/02.05.InteractiveExhibitions.Final.pdf>
- Pellegrini, A. D. (Ed.). (2011). *The Oxford Handbook of the Development of Play*. Oxford, UK: Oxford University Press.
- Poole N.(2015). How to Write an Audience Development Plan- Issues to Consider, Research to Conduct. Retrieved September 20, 2015, from <http://www.museum-id.com/idea-detail.asp?id=353>
- Rader, Karen A., and Victoria EM Cain. *Life on Display: Revolutionizing US Museums of Science and Natural History in the Twentieth Century*. University of Chicago Press, 2014.
- Serrell, B. (1998). *Paying Attention: Visitors and Museum Exhibitions*.
- Serrell, B. (2015). *Exhibit Labels: An Interpretive Approach* (2nd Rev ed.).
- Simon, N. (2010). *The Participatory Museum*. Santa Cruz, CA: Museum 2.0.
- Simon, N. (2015, November 25). [Personal interview by the author].

- Smithsonian Institution. (2002, September). Exhibitions and their Audiences: Actual and Potential. Retrieved from <http://www.si.edu/Content/opanda/docs/Rpts2002/02.09.ExhibitAudience.Final.pdf>
- Strategic Plan 2013-18. (n.d.). Museum Victoria.
http://museumvictoria.com.au/pages/1711/mv_strategic_plan_2013-18.pdf
- Think Ahead. (n.d.). Retrieved September 18, 2015, from Museum Victoria: Scienceworks website:
<https://museumvictoria.com.au/scienceworks/whatson/current-exhibitions/think-ahead/>
- Wallace, M. A. (2010). *Consumer Research for Museum Marketers: Audience Insights Money Can't Buy*. Plymouth, UK: AltaMira.
- Wells, G. (1981). *Learning Through Interaction: Volume 1: The Study of Language Development (Vol. 1)*. Cambridge University Press.
<https://books.google.com/books?hl=en&lr=&id=HV23MTRFMf8C&oi=fnd&pg=PR7&dq=children+learning+through+questions&ots=S539R7G79C&sig=IcggE6tmT21qWhm1xe5JcaszJ8E#v=onepage&q&f=false>

Appendix A: Tracking Instrument

Tracking Instrument- Demographic, Large Area & Exhibition Times

Visitor Track Number:						
Investigator:		Location:				
Date:		Weekday:				
Description:						
Individual Demographics:	Gender:		Attitude:			
	Age:					
Group Demographics:	# adults:		Leader:			
	#children:		School?:			
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT						
			0:00		0:00	
			0:00		0:00	
			0:00		0:00	
			0:00		0:00	
			0:00		0:00	
			0:00		0:00	
			0:00		0:00	
			0:00		0:00	

Tracking Instrument- Exhibit Times & Interactions with Notes

[illegible]

Appendix B: Interaction Descriptions

<u>Interaction Descriptions</u>	
Interaction Type	Description
Push	<i>Pushing is an interaction where the visitor physically exerts a force on an object or button away from his or her body. A push is generally made away from the body. Each different push is recorded. For example, if the same button is pressed several times it is only counted as one push; however, if the visitor pushes one button, then pushes the button next to it, and then pushes the original button again, this would be considered three pushes. Pushing also encompasses pushing a wheelbarrow or a microscope slide.</i>
Pull	<i>A pull would be an interaction where the visitor exerts a force to move the object toward their body. A single pull would encompass from the time the visitor started pulling on the rope, until the time they let go. Examples include pulling a rope, a pulley, or a lever.</i>
Turn	<i>A turn generally includes a movement in a circular direction wholly or partly around an axis or point. A single turn would be from the time the visitor put their hands on the wheel, until the time they removed their hands. Even though the wheel may have been turned a full five times by one individual, only one is recorded since the task may be able to accomplished at a different number of turns per each person. Examples include spinning hypnotic wheels, turning visual illusion displays, or turning wheels to move pulleys.</i>
Lift	<i>A lift would be an interaction where the visitor picks up an object to move it to a different location. In most cases, each lift would be recorded, although if a visitor was lifting several blocks, it would still be considered one lift. Examples include lifting a wheelbarrow or lifting panels to view what is underneath.</i>
Touch	<i>The touch interaction is recorded if a visitor contacts an exhibit with his or her hand, without adding a force such as a push or a pull. The touch interaction is typically recorded when touch screens are used, but are also marked off if a visitor comes in contact with a display.</i>
Hit	<i>A hit interaction is much more forceful and quicker than a 'push.' Hits include banging on instruments or hitting buttons to test hand-eye coordination and reaction time. If a single instrument is hit several times it will account for one hit. If nine different instruments are hit, nine hits will be recorded.</i>

Point	<i>Pointing occurs when a visitor extends his or her finger, or something held in his or her hand, at a specific part of an exhibit that they are at. If a visitor were to point across the room to a different part of the exhibition, that would not be recorded.</i>
Watch	<i>Watching can happen in two instances: looking at a video or looking at an exhibit that others are using. For instance, the recyclatron has several videos to watch and many exhibit parts to interact with. If someone is turning the wheel at the paper part of the recyclatron, a child may watch the exhibit since they can see what is happening being that someone else is already completing the interaction. Watching others also occurs at Future You, the excavator, the wheelchair race, and the race against Cathy Freeman.</i>
Read	<i>'Read' is marked off when words are comprehended, whether it be from a screen or on a placard. It is also relevant where an adult reads instructions/placards with the child.</i>
Listening (Hear)	<i>The 'hear' interaction occurs when a visitor listens to different audio recordings. These are specifically marked off when listening to music, sounds, or audio messages.</i>
Create	<i>Creating occurs when a visitor makes, designs, or constructs something that wasn't originally there. If a visitor continues to build one item, they will receive one create. If a child were to design five future cars, then they will receive five creates for that exhibit. Prime examples include wall building, designing your future self, building your own future car, preparing a meal at the cafe, or making music on instruments.</i>
Social Play (SocPl)	<i>During social play, a visitor will interact with family members or other visitors in order to accomplish an activity. The goal in social play is to play in a parallel and cooperative manner. Within an exhibit, social play will be marked off once for each different child the visitor plays with. If the visitor were to spend five minutes at the ball roll with one child, they would receive one mark for social play; if they were to spend five minutes at the ball roll, but engage with three different children, then they would receive three social plays. Typically social play occurs at the wall building, Future Cities, or at the ball roll in the Alice's Wonderland exhibition.</i>
Leg Movement (Legs)	<i>The 'legs' interaction occurs when a visitor physically uses their legs to interact with the exhibit. Examples include jumping, riding a bike, or standing on a snowboard.</i>
Arm Movement (Arms)	<i>The 'arms' interaction occurs when a visitor physically uses their arms to interact with the exhibit. Examples include throwing a ball, operating the excavator, rolling a ball, or using the wheelchair race.</i>

Body Movement (Body)	<i>The 'body' interaction occurs when a visitor uses their whole body to complete an activity. Examples include running or crawling. If a race is run five times, five 'body' interactions will be recorded.</i>
Having a Bad Conversation (BadCon)	<i>A 'badcon' is recorded if the visitor is disciplined by their parents or the museum staff, or acts out to their parents.</i>
Having a Good Conversation (GoodCon)	<i>A 'goodcon' is recorded when the visitor is clearly talking about the exhibit with their family or other visitors. Good conversation includes asking questions about the exhibits, having parents or guardians discuss meanings of exhibits, or talking about exhibit material in general.</i>
Texting (Text)	<i>'Text' is marked off when a visitor uses their phone for non-educational reasons. This includes answering texts or checking Facebook.</i>
Taking a Photo (Photo)	<i>While 'photo' is only marked off if a visitor takes the photo him/herself, a note is made if another family member takes a photo of them. Selfies with exhibits or photos of exhibits would be recorded under 'photo.'</i>

Appendix C: Tracking Guide

Preface

Tracking itself seems to be a simple concept, but in reality it is a lot harder than it sounds. This is especially true for tracking in an interactive based museum. People move quickly in a museum and it can be easy to lose someone while keeping track of all the data you intend to collect. This guide will hopefully provide you with the procedures necessary to complete a successful tracking study. Also included are tips to help you while you are tracking.

Preparation and Division of Responsibilities

To aid in the comprehension of this guide, the following definitions have been provided:

Exhibition- A large selection of items, often united by a theme.

Exhibit- A single item or small collection of objects, which together make an exhibition. The Grammarist uses the example- a single dinosaur skeleton in a museum would be an exhibit, whereas a collection of dinosaur skeletons in the wing of a museum would be an exhibition.

In preparation for your day of tracking in an interactive museum, you need to be aware of your museum's layout and make sure you have all the required items. First, it is recommended that you have two members on your tracking team: one member will draw the path of the visitor on the map, and the other member will record the time spent at exhibits. The team member who has the steadiest hand should do the drawing, as the lines must be kept neat and crossing paths must be clear. See the hand-drawn map below (Figure A) for an example. Both members will record interactions such as pushes, pulls, turns, etc. that the visitor had with specific exhibits on the interactions sheet. A detailed description of these interactions can be found at the end of this guide.

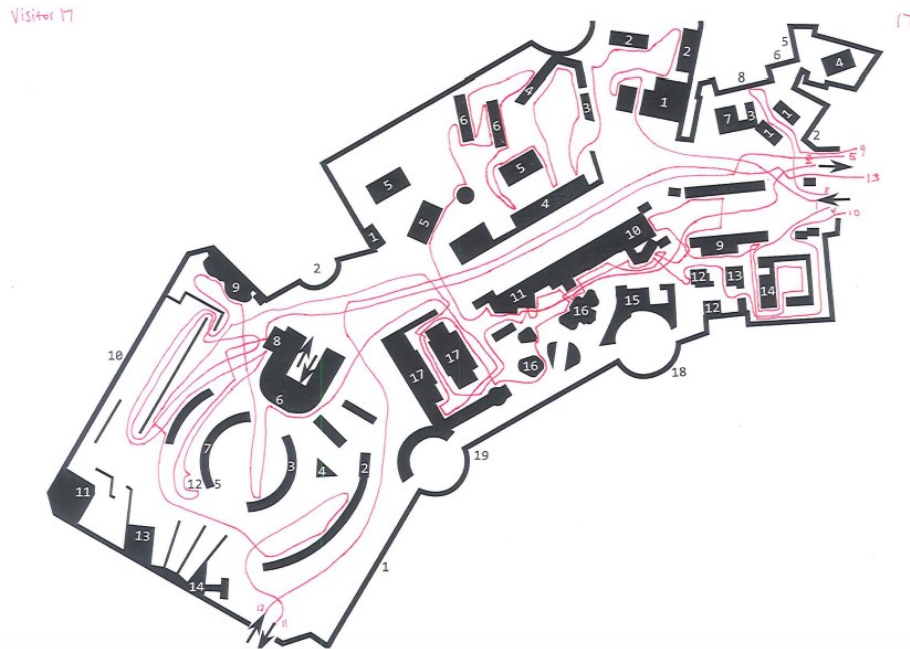


Figure A: Hand-drawn map

For clarity, the team member who is drawing the pathways on the map will be called **The Mapper** throughout the rest of this guide.

The team member who is keeping track of the time spent at the exhibits will be called **The Time Keeper** throughout the rest of this guide.

Materials

Once the roles have been selected, you must make sure each member has all the necessary materials.

The Mapper needs the following:

- A red or other brightly colored felt tip pen
- Blank, **detailed maps** of all exhibit spaces and a **general map** of all floors
- An **interactions sheet** for marking off interactions completed by the visitor being tracked
- A list of **predetermined exhibit codes**
- A **clipboard** to keep all of your paper organized. The map can be on one side, and the behavioral interactions can be taped to the other side. Flipping the clipboard back and forth makes it easy to accurately record the pathways and the interactions.

The Time Keeper needs the following:

- A **phone or watch** to keep track of time spent at exhibits. Time will be kept to the minute, a device that displays seconds as well is not needed.

- A **notebook or notepad** to write down the times and demographic data (much easier to write down times and transfer to spreadsheet instead of writing in small boxes of printed out spreadsheet)
- An **interactions sheet** for marking off interactions completed by the visitor being tracked
- A list of **predetermined exhibit codes**
- A **pen or pencil** for writing down all times
- A **clipboard** to keep all of your papers organized

Some of these materials will not be readily available, and must be created from scratch. These include: the **blank maps of general spaces and detailed maps of exhibits**, the **predetermined exhibit codes**, and the **interactions sheet**.

In order to make the **maps**, any existing map of the museum must be modified to an acceptable level of detail. If the museum has a visitor map, use it to go through the museum and mark the location and shape of all exhibits. If the museum doesn't already have a more detailed layout on file, the maps must be created from scratch, and a program such as Inkscape can be used.

While creating the maps, exhibits should be grouped appropriately within their exhibition and given a code. For example if one area of an exhibition has to do with money and contains multiple related exhibits, then that area would have the same code. To see an example of blank maps, complete with coded exhibits, see the attached blank maps below (Figure B and C).

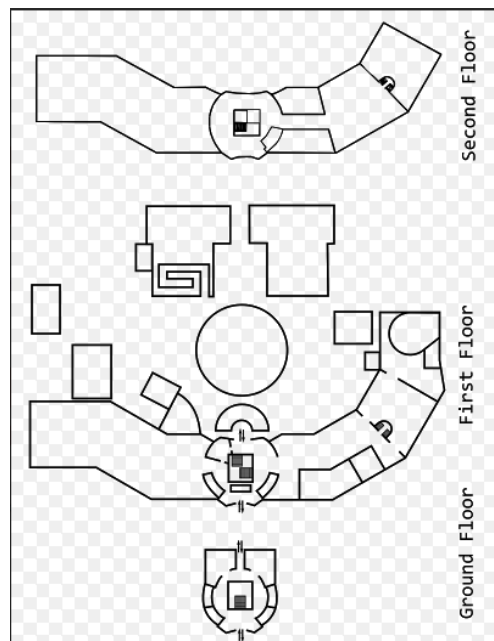


Figure B: Blank, general map of all floors

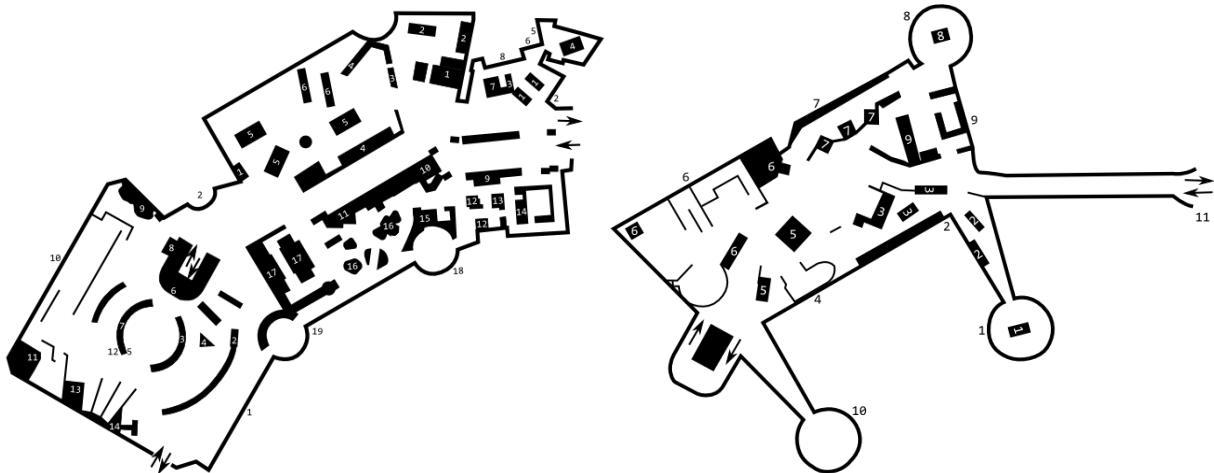


Figure C: Blank, detailed maps

The list of **predetermined exhibit codes** will be used as shorthand abbreviations in your tracking documents in order to minimize the amount of time required to record them.

You will need codes for:

- ☐ Large areas and exhibitions
- ☐ Exhibits within the exhibitions

The **large areas** include areas such as the entrance, the cafe, and the main exhibitions. These codes should be three letters and you should be able to tell what they are from looking at them. For example, the cafe can be abbreviated CAF and the entrance can be abbreviated ENT. An exhibition named Think Ahead can be abbreviated THA.

The codes for the **exhibits** will be dependent on how you group them within your blank map; this will be done based on the flow of the exhibits and your team's discretion. Think about grouping exhibits with like themes, such as environment, or vehicles. Colors and fonts can also provide insight into intended groupings that the exhibit designers may have had in mind. Each of these exhibit groups will have a number. The numbering will not continue across exhibitions. This means that you can have four exhibits labeled one, but you must make it clear that they are from different exhibitions as you track. To summarize, the complete list of codes should include both the code "THA1", and the name "Think Ahead #1: Money Exhibit", but only "THA1" would appear on your tracking sheet. By using these codes on the timesheet and interactions sheet, less time will be spent on writing down the exhibition and exhibit names, and more on observing the visitor's interactions.

The **interactions sheet** may vary from museum to museum but the interaction descriptions explained at the end of the document should fit for most. If additional interactions may occur, or not all interactions are possible at the museum, adjust your interactions sheet accordingly. An example can be seen in Figure D in the During the Track Section below. Before you begin your tracking, it would be beneficial to go through each exhibit within the museum and record the

possible number of interactions at each exhibit. This ensures that you are not missing any interactions.

Once you have all of your materials, you are ready to begin tracking.

Helpful Tips

It is important to note that the length of a track is unpredictable. Some visitors may spend a large portion of their time at the museum, as some tracks can last four or more hours. During these long tracks, a visitor will usually stop for lunch at the cafe or will go to a show. If you bring your lunch with you in a small bag you will be able to have your lunch break during this time. It is also recommended that you bring a bottle of water with you to stay hydrated during the track.

The Need for Signs

It is imperative that you have the museum provide you with signs to put in the main lobby, informing visitors that they may be observed for research purposes. This serves as a warning to all visitors and makes sure they are not alarmed by people with clipboards following visitors around. A sign could say:

“We are observing visitors. Our museum is keen to find out how visitors are experiencing our exhibitions. You may notice our researchers observing visitors as they explore and utilize the exhibits. Please advise the researchers if you’d like to be excluded from the observations. Thank you, we hope you enjoy your visit.”

Beginning the Track

Once you are all set to begin tracking, your team should head to the lobby of the museum and wait for people to enter. Make sure you have put all the previously mentioned signs about visitor observation taking place in easy to read spots, such as registration desks, information kiosks, or ticket counters. It is helpful to be in the lobby when the museum opens, that way you have more visitors to choose from.

Before choosing who to track...

The Mapper should make sure to:

- Write down the track number, the date, and the day of the week at the top of each map sheet.

The Time Keeper should make sure to:

- Write down the track number, the date, and the day of the week at the top of their note sheet.

By writing down this data, it will keep all sheets and maps organized. It also ensures that if you do not input data on the day you tracked, you will still know when this track took place.

Choosing who to track...

Choosing who you want to track depends on what you are trying study. Before you started your study you should have been given a demographic to look for. For example if you are supposed to be tracking children ages three to twelve you will want to get a wide variety of ages within that range and maybe a 50/50 male to female ratio. It does help if you choose someone with a highly identifiable item of clothing as it makes it easier to spot him or her from across the room. This is not imperative, but can be helpful. Fulfilling your demographic should always come first.

After you have chosen whom to track...

The Mapper should make sure to:

- Record demographic details on top of the interactions sheet.
- Note a brief description of the group.
- Begin drawing map, by marking which entrance the visitors entered through.

The Time Keeper should make sure to:

- Record demographic details in notebook.
- Write down a category for leader of the group (whether it be a child or adult) and leave it blank. This will be filled out during the track once it becomes clear.
- Note a brief description of the group.
- Record the time that the track entered the museum. This is important for determining the length of the whole stay.

Each member should note demographic details. These demographic details include the gender, the approximate age, the attitude of the person being tracked, the number of children in the group, and the number of adults. All of these details are important for analysis later on. It is also a good idea for each member to write down a brief description of the group beyond just the number adults and children. An example of this would be “Young girl with baby sister, mother, father, grandpa.” Now it is time for the track to begin.

During the Track

Once the track has started there are many things you have to keep in mind.

- Stay four to six meters away from your subjects. You do not want to give them the impression that you are following them.
- While it may seem impossible when carrying clipboards, try and blend in with the rest of the visitors at the museum. If you are close to the visitors you are tracking, don't be afraid to play with nearby exhibits to take your eyes off the visitor. Make it seem like you are

inspecting exhibit elements. The important thing to remember while doing this is that at least one member of the tracking team must have their eyes up so that no interactions are missed.

- Tracking team members should not be together throughout the whole track. Members should be “inspecting” different exhibits with the visitor being tracked in clear sight; comparison of interactions observed should occur often.
 - If there are benches available, members can sit next to each other to compare data while subjects are not actively engaged with exhibits.
- Whenever possible, get to a higher vantage point where you can see the whole floor of the museum. This gives you a good place to view your track without getting too close to them in cluttered spaces. Observing from a higher vantage point is especially useful for the Mapper; it provides them with a great viewpoint to see every path taken, and depending on the museum, it may provide them with plenty of space to draw without getting bumped around.
 - If the Mapper is up a floor with a high vantage point, Time Keeper might want to be down on the floor closer to the track to get an up close view of the interactions. This allows for two different points of view of the group you are tracking.
- At certain points your tracked visitor may take off quickly. If this happens the Time Keeper should walk quickly to catch up with them so that the Mapper can finish drawing their track. This ensures you do not lose your track. Once the Mapper has caught up, the Time Keeper can tell the Mapper what path was taken to make sure the whole track is recorded.
- Both team members should carry their cell phones just in case they get separated and the one member needs to find the subjects quickly.

Responsibilities of the Mapper:

- Draw the path of the track throughout the museum.
 - Make sure the lines are neat, clear, and distinct. Distinct stops should be highlighted by drawing the path very close to the exhibit numbers, or with a sudden change in line direction. Imagine a visitor that approaches an exhibit from one direction, and then continues in another, shown with a sharp angle on your map. When lines cross over make sure the flow of the pathway is distinct. In other words, try to maximize the angle between crossing lines. Shallow angles lead to confusion where two crossing lines could potentially diverge in either of the two directions.
 - Each pathway to/from the entrance, stairs, or exits should be labeled with a number. Since it is possible that you will have more than one map, this lets you retrace the pathways later on.
 - Sometimes a visitor will make short, quick changes in direction, especially younger ones. It is up to the discretion of the tracker to determine how much of each track to draw. An exact track of children lends itself to very noisy data.

Both members of the team are keeping track of the interactions that the visitor has with the exhibits. It is advised that you set up your interactions sheet as shown in Figure D above. The exhibit or set of exhibits with the same number code are recorded on the left hand side in the rows, and the different interactions are listed at the top and each have their own columns. These exhibit codes should be listed in the order that the exhibits were visited, and therefore cannot be entered ahead of time. Interactions are filled out on the sheet by number of interactions that were done at each exhibit. For example, if a visitor pushes four buttons at an exhibit, the number four would be written under the push column in the row you designated for that exhibit.

In addition to recording the physical interactions, there is also a column for notes. While observing the visitor, make sure you write down anything noteworthy. Examples can include beelining to a particular exhibit, staying at an exhibit for a long time to complete the activity several times, or having their picture taken. These notes can help you make conclusions about visitors when you analyze them later on.

As previously mentioned, both members of the tracking team should be very familiar with how all exhibits in the museum work. Quite often you may not be able to see exactly what is happening at an exhibit. Familiarity with exhibits allows you to know what interactions are happening when you cannot see them. Sometimes you may have to make judgment calls on interactions based on your distance from the subjects. At these points, talk it over with your tracking teammate and come to a quick consensus on what just took place.

If the visitor you are tracking enters an area of the museum where you know they will be for a long time, make sure you position yourself in such a way that you can observe them leaving that area. Examples of this include a stop for lunch at the cafe, stopping for a show at a theater, or visiting an extended demonstration. Find a position where you know the subject will have to pass in order to leave. It is of the utmost importance that you do not lose your track in one of these situations because it will be almost impossible to find them if you do. If there are multiple exits split up and make sure you have eyes on all exits.

Getting Caught

No matter how well you try to blend in, you still may be caught at some point during your tracking study. In most cases, the signs you placed in the main lobby will be your safeguard. Most people will read these, understand what is going on, and have no problem with it. Just be honest if a visitor comes up to you during your track and asks what you are doing. Tell them that you are doing a study for the museum where you are observing visitors to see how they interact with the exhibits around them. Most people will be satisfied with this answer and continue with their visit. If they are not satisfied with that explanation, ask them if they would like you to stop tracking them. If they say yes, end the track there and head back to the lobby to find a new visitor. If a visitor becomes confrontational about the observation, make sure you get a staff member involved, preferably higher management. As with all business ventures, the customer is the most important

person and the priority is to make them comfortable. Overall, if any problems arise stop the track and move on to a new one.

Ending the Track

When the tracked visitor leaves the building:

The Mapper should-

- Draw the pathway ending where the visitor exited.
- Ensure that all pathways are complete on the map and all are numbered appropriately.

The Time Keeper should-

- Write down the time of exit from the building on the same sheet where you recorded the entering time, and the exhibition in and out times.
- Write down the number of stops in each exhibition. This is done by looking at the page where you wrote down all of your exhibit in and out times. For each exhibition time in and time out, you should have a chunk of exhibit times in and out. After counting the number of exhibits that were visited within this exhibition, write down this number next to the time frame on your note sheet. Repeat this for all explored exhibits.
 - For example, if your track went into the dinosaur exhibition at 11:30 and left it at 12:20, you should have a list of exhibit times in and out during that time frame for the dinosaur exhibition. These exhibits should be counted up. This is the number of stops for the dinosaur exhibition during that nearly one-hour time frame.

Once both members have completed the above, the track is finished. If there is time for another track, you'll want to start the whole process again. If not, pick up your signs and pack up. The only thing left to do is input your data. This process should easily net you large amounts of useful interactive data to be analyzed, and then allow you to draw conclusions about your interactive museum. This may seem like a complicated process but in reality once you have done this process a few times it will become repetitive and easy to follow. Hopefully you have found this guide helpful. Happy tracking!

Interaction Descriptions

Interaction Type	Description
Push	<i>Pushing is an interaction where the visitor physically exerts a force on an object or button away from his or her body. A push is generally made away from the body. Each different push is recorded. For example, if the same button is pressed several times it is only counted as one push; however, if the visitor pushes one button, then pushes the button next to it, and then pushes the original button again, this would be considered three pushes. Pushing also encompasses pushing a wheelbarrow or a microscope slide.</i>
Pull	<i>A pull would be an interaction where the visitor exerts a force to move the object toward their body. A single pull would encompass from the time the visitor started pulling on the rope, until the time they let go. Examples include pulling a rope, a pulley, or a lever.</i>
Turn	<i>A turn generally includes a movement in a circular direction wholly or partly around an axis or point. A single turn would be from the time the visitor put their hands on the wheel, until the time they removed their hands. Even though the wheel may have been turned a full five times by one individual, only one is recorded since the task may be able to accomplished at a different number of turns per each person. Examples include spinning hypnotic wheels, turning visual illusion displays, or turning wheels to move pulleys.</i>
Lift	<i>A lift would be an interaction where the visitor picks up an object to move it to a different location. In most cases, each lift would be recorded, although if a visitor was lifting several blocks, it would still be considered one lift. Examples include lifting a wheelbarrow or lifting panels to view what is underneath.</i>
Touch	<i>The touch interaction is recorded if a visitor contacts an exhibit with his or her hand, without adding a force such as a push or a pull. The touch interaction is typically recorded when touch screens are used, but are also marked off if a visitor comes in contact with a display.</i>
Hit	<i>A hit interaction is much more forceful and quicker than a 'push.' Hits include banging on instruments or hitting buttons to test hand-eye coordination and reaction time. If a single instrument is hit several times it will account for one hit. If nine different instruments are hit, nine hits will be recorded.</i>
Point	<i>Pointing occurs when a visitor extends his or her finger, or something held in his or her hand, at a specific part of an exhibit that they are at. If a visitor were to point across the room to a different part of the exhibition, that would not be recorded.</i>

Watch	<i>Watching can happen in two instances: looking at a video or looking at an exhibit that others are using. For instance, the recyclatron has several videos to watch and many exhibit parts to interact with. If someone is turning the wheel at the paper part of the recyclatron, a child may watch the exhibit since they can see what is happening being that someone else is already completing the interaction. Watching others also occurs at Future You, the excavator, the wheelchair race, and the race against Cathy Freeman.</i>
Read	<i>'Read' is marked off when words are comprehended, whether it be from a screen or on a placard. It is also relevant where an adult reads instructions/placards with the child.</i>
Listening (Hear)	<i>The 'hear' interaction occurs when a visitor listens to different audio recordings. These are specifically marked off when listening to music, sounds, or audio messages.</i>
Create	<i>Creating occurs when a visitor makes, designs, or constructs something that wasn't originally there. If a visitor continues to build one item, they will receive one create. If a child were to design five future cars, then they will receive five creates for that exhibit. Prime examples include wall building, designing your future self, building your own future car, preparing a meal at the cafe, or making music on instruments.</i>
Social Play (SocPl)	<i>During social play, a visitor will interact with family members or other visitors in order to accomplish an activity. The goal in social play is to play in a parallel and cooperative manner. Within an exhibit, social play will be marked off once for each different child the visitor plays with. If the visitor were to spend five minutes at the ball roll with one child, they would receive one mark for social play; if they were to spend five minutes at the ball roll, but engage with three different children, then they would receive three social plays. Typically social play occurs at the wall building, Future Cities, or at the ball roll in the Alice's Wonderland exhibition.</i>
Leg Movement (Legs)	<i>The 'legs' interaction occurs when a visitor physically uses their legs to interact with the exhibit. Examples include jumping, riding a bike, or standing on a snowboard.</i>
Arm Movement (Arms)	<i>The 'arms' interaction occurs when a visitor physically uses their arms to interact with the exhibit. Examples include throwing a ball, operating the excavator, rolling a ball, or using the wheelchair race.</i>
Body Movement (Body)	<i>The 'body' interaction occurs when a visitor uses their whole body to complete an activity. Examples include running or crawling. If a race is run five times, five 'body' interactions will be recorded.</i>
Having a Bad Conversation (BadCon)	<i>A 'badcon' is recorded if the visitor is disciplined by their parents or the museum staff, or acts out to their parents.</i>

Having a Good Conversation (GoodCon)	<i>A 'goodcon' is recorded when the visitor is clearly talking about the exhibit with their family or other visitors. Good conversation includes asking questions about the exhibits, having parents or guardians discuss meanings of exhibits, or talking about exhibit material in general.</i>
Texting (Text)	<i>'Text' is marked off when a visitor uses their phone for non-educational reasons. This includes answering texts or checking Facebook.</i>
Taking a Photo (Photo)	<i>While 'photo' is only marked off if a visitor takes the photo him/herself, a note is made if another family member takes a photo of them. Selfies with exhibits or photos of exhibits would be recorded under 'photo.'</i>

Appendix D: Survey Material

Survey Questions

Your participation in this interview is completely voluntary and will only take about two minutes of your time. You may withdraw from the interview at any time. Please remember that your answers will remain anonymous. No names or identifying information will appear in any of the project reports or publications.

1. Which exhibit was your most favorite?
2. Which exhibit was your least favorite?
3. Which exhibit did you find to be the most educational?
4. Which exhibit did you find to be the least educational?

Survey Board



Appendix E: Exhibit Observations

The tracking team observed visitors for over sixty hours to determine their pathways and interactions with exhibits. While tracking visitors, detailed notes were taken and general observations on other visitors were made. Upon completion of the tracking segment of the project, the tracking team sat down and composed notes on each exhibit within Scienceworks. These notes are common observations and descriptors, organized based on exhibition, and our predetermined exhibit number. The name of each exhibit is included as well.

<u>Think Ahead</u>		
Exhibit #	Name of Exhibit	Observations
1	Computer Games, Robots	<i>This exhibit is a part of the exhibition that is often not explored. The right hand side of Think Ahead does not get many visitors according to our tracks. When this exhibit is visited, the highlights are the writing in the air, controlling the ship through the tunnel, and looking at the different video game controllers. Usually this is a quick stop on the way to the city exhibit. On the back wall, the small exhibit about robots does not get stopped at much. When it does, many people just look at the display and do not realize that you can touch the screen next to it to learn about the NAO robot.</i>
2	Money	<i>This exhibit is also not explored that often. The main attractions for this exhibit are the part where you try to lift the bag of two-dollar coins and where you spin the poverty wheel. The wall with all of the counting devices and examples of money has rarely been looked at during our observations.</i>
3	Future Jobs	<i>This tablet almost never gets stopped at. Only one of our twenty-one tracks made a stop here. The tablet itself is kind of hidden and tucked away so this could contribute to its lack of utilization.</i>
4	Future Visions	<i>This exhibit is part of the corner that rarely gets visitors. When they do visit this section they never touch the buttons that allow visitors to hear experts of various fields talk about their areas of expertise. Highlighting the fact that there is a 3D printer in this corner could increase viewership.</i>
5	Future Bedrooms	<i>This is also part of that corner. Admittedly this does get more viewership when visitors come to this corner, but again that is not often. The views for this are quick and fleeting. Children take a look and move on to the tablet nearby where they can create a future shoe. Nothing holds their attention here.</i>
6	Future Clothes	<i>This exhibit gets the most viewership of any in this corner. The tablet for designing your own shoe draws the attention of most children in this area. One thing to note is that while the tablet gets attention, the display</i>

		<i>of advancements in clothing for the future gets little to no looks as the only people who rarely look at it are adults.</i>
7	Future Environment	<i>This exhibit gets a decent amount of coverage. Many children love pushing the buttons to watch the hydraulic canister move from one side of the exhibit to the other. They also enjoy reaching in the holes to identify the recyclables. The three little pigs displays are also viewed. The one part that does not get as much love is the touch screen where you can see how much energy different appliances use.</i>
8	Future Cities	<i>The centerpiece of this exhibit gets visited very often. Children seem to enjoy and have fun seeing how the blocks they move also move on the screen. Unfortunately many do not seem to understand the concepts behind rotating the block to create different buildings to complete an objective. For the other part of the exhibit, many children seem to be intrigued by the wheel they can turn to see how to prevent buildings from collapsing during earthquakes and the touch screen to see how Melbourne would be affected by different environmental events.</i>
9	Communication	<i>This exhibit gets passed more often than not. The amount of information seems overwhelming to many children. Upon entering Scienceworks, this exhibit appears as a tunnel. When children do stop here it is usually to watch one of a few videos playing in the area, play with the binary code touchpad, or press the hydraulic canister button and watch it move over to the transport area. This exhibit mainly seems to be a conduit for visitors to other exhibits.</i>
10	Transport	<i>This exhibit is one of the most stopped at exhibits in Think Ahead, mainly due to its vast size. The EN-V car attracts several visitors and the example bike that they can sit on draws visitor's attention, as a number of our tracks sat on the bike at one point or another. Many were also intrigued by the touch screens that tell visitors about all of the vehicles in the glass display or the traffic game. The wheel to turn the omni wheel and the battery example also get a decent amount of attention. The only weak spot of the exhibit seems to be the cargo ship that you can load up and try to balance. We observed very few visitors unpacking it and trying to repack it for balance. This could just be a general lack of awareness that this is the intent of the activity.</i>
11	Car Making	<i>This is one of the highlights of the Think Ahead exhibition. This area is always crowded and is rarely seen empty. The children are usually enthralled with exhibit and make more than one car. Not much else can be said about this exhibit other than it seems to work perfectly for the audience.</i>
12	Future You, AI/AR, Badge Making	<i>This may seem like an odd grouping of exhibits, but they are all right next to each other. The Future You is the biggest success of this area. Many children and families are always crowded around this part of the exhibit and after watching their completed video, many e-mail the video to themselves. The badge-making tablet also draws visitors. Many visitors play around with this tablet. The only weak point seems to be the tablet about the growth of Artificial Intelligence and the NAO robot. The tablet rarely gets looked at and people generally just walk by NAO without looking at it. They just do not seem to know what to do with it.</i>

13	Music	<i>This exhibit often gets overlooked in favor of the nearby Future You, but it does not go completely unnoticed. Quite a few people will listen to the videos on experimental instruments and music players. Those who understand what to do with digital harp always enjoy it, but some just do not get what is there and walk by.</i>
14	Sound Room	<i>This room frequently gets visited first in Think Ahead. Many will go in and spend a few minutes playing around with the tablet. Quite a few people spend a decent amount of time in this exhibit. There are noticeable weaknesses with this room though. Some visitors do not get that the emotion buttons are for you to push based off how you are feeling with what you hear. Many will just push buttons to push buttons. Finally, we gathered from our surveys that some visitors find the room overwhelming.</i>
15	Medicine	<i>This is the most overlooked exhibit on the left hand side of Think Ahead. It is the corner of Future You that holds these two displays. It very frequently gets passed by. With all the other exciting exhibits around, there is nothing to really draw the attention of the visitors to this exhibit. We only observed one of our tracks look at this exhibit. Children rarely went up to these displays on their own, and most were called over by a parent or grandparent.</i>
16	Nature	<i>This exhibit gets interacted with often. Children enjoy watching the rocket go off and pressing the button to look at the ice crystals. They also like the wheel they can turn to look at different kinds of food. Finally, the ocean part of the exhibit with the fish in nets also usually gets looked at but many visitors do not seem to realize they can touch it. The main weakness is that for all of text in this exhibit, barely any of it gets read. The few exhibits mentioned above are looked at and that's it for the most part. The wall with the apples and the giant Erlenmeyer flask are hardly ever looked at. The same goes for the videos in the area- barely any of them get watched.</i>
17	Space	<i>This is also one of the most popular areas that visitors stop at. The most popular parts are walking through the rotating spaceship and going in the transportation tube where you come out the other side. Quite a few children also spent a good amount of time creating their own alien and postcard from another planet. The cans for gravity on different planets are also somewhat popular. The only unpopular part is the tablet where you can read about space travel. Very few people seem to read that.</i>
18	Biotech Room	<i>This room is mainly used as a passageway. Some visitors stop and look at the tablet about medical advances or take a look at the machines. Not much is done in this room if it ever gets visited, which does not seem to happen very often.</i>
19	Train Room	<i>This room is also mainly used as a pathway. This is the exhibit that had the least interaction of any in the museum during our study. Nobody read the descriptions of the train identification on the walls and nobody tried the pump that demonstrates the train moving. If people go in this room it is to sit down or walk through it.</i>

Nitty Gritty Super City

Exhibit #	Name of Exhibit	Observations
1	Meteorology	<i>About half the visitors visit meteorology. Since it is down the hallway, it can be overlooked. Children typically enjoy matching the correct outfits to the weather.</i>
2	Weather Equipment, Microscopes	<i>Several children will look in the microscopes, however almost no one even takes a glance at the weather equipment. There is a lot of text about each of the different apparatuses and the text is small. There is no draw here, and the text and equipment may be out of view of a small child. This display does not seem appropriate for a child aged 3 to 8.</i>
3	Creatures	<i>Many people will take a look at this exhibit. The taxidermied animals are one of the first exhibits visitors see as they walk in. People who visit this exhibit tend to move the microscope slides to look at the bugs and will push the buttons to listen to the different noises that creatures such as bats, cicadas, etc. make.</i>
4	Boat	<i>For being completely interactive, the boat exhibit does not get as much traffic as was expected. There aren't many tasks to be completed here with there being only one pulley, a couple of blocks, a telescope, and a steering wheel. Most children tend to wander in the boat, look around, maybe touch the wheel or pulley, and then move on.</i>
5	Floor Displays (Bike, Lego City, Clock-tower)	<i>The floor displays are frequently visited. Almost every visitor will sit on the bike, which frequently leads to their parent or guardian snapping a photo. Lego City also gets a great deal of visitors. Nearly every visitor will have a look at Lego City, regardless of age. It is a very popular exhibit, especially when the push of a button can direct your eye to that particular landmark. The only recommendation for Lego City would be to make the "I spy" aspect more obvious. The light orange font almost blends into the orange background it is on. The top of the exhibit says, "Can you find..." and then randomly has scenarios for visitors to find. For example, "Can you find...someone flying a kite?" By having the writing on top of the exhibit, small children will not see it, for it is not in their direct field of vision. This aspect of the exhibit can be very engaging and fun if done right.</i>
6	Construction, Building	<i>This exhibit is one of the most favored and visited at Scienceworks. Visitors will spend large segments of their stay using foam blocks to build the wall. There are many tasks for children to participate in: using a wheelbarrow to move blocks from one side of the wall to the other, pulling/turning a pulley to move the blocks up the wall, turning a wheel to move the conveyor belt of blocks to the top of the wall, placing the blocks into the empty space on the wall, or pushing unused blocks in a slot to move them off the top of the wall. Typically a child will do several task while at the wall. The excavator is another favorite among visitors, although some don't get to use it because they miss the button which activates it. The button is off to the side and the sign is not blatant. If a visitor doesn't immediately see the button, they will move on thinking</i>

		<i>that the excavator is broken. The tool pairing and pulleys get a decent amount of traffic as well. The bridge and sculpture building get the less traffic within this exhibit.</i>
7	Recycling	<i>Almost all visitors tend to at least walk through the recyclatron. Children will push the button/ turn the wheel to activate specific parts of the recyclatron. Few people will actually watch the videos or read the signage.</i>
8	Music Bowl	<i>About half the people who visit Nitty Gritty will go into the music bowl. It can get very loud considering there are nine different instruments consisting of bells, chimes, and xylophones. The noise tends to deter some people away. Other people will go into the room to look at themselves in the mirrors.</i>
9	Play Cafe	<i>This exhibit gets a good amount of visitors. Children who play in this area tend to spend a decent amount of time there. They will “make meals” and some will even bring them to other children or their parents/guardians. The piano in there also receives frequent visitors. The panels children can lift to see where food comes from is also popular for inquisitive children.</i>
10	Observation Room	<i>The observation room gets little to no visitors. There is not much to do in there. The only thing to see is the view of the City; however, the observation binoculars in the room are pointless, since if you look through them you can only see a tree. The whole view is blocked.</i>
11	Nitty Gritty Hallway	<i>Only a few visitors stop at the steam engines or the tic-tac-toe. Children are generally very excited to go visit Nitty Gritty Super City and run right past these displays.</i>

Sportsworks

Exhibit #	Name of Exhibit	Observations
1	Visual Illusions	<i>During our time tracking, this exhibit moved from being next to Sportsworks to over in the Special Exhibition gallery. This did not affect the general observations of this exhibit. Generally speaking, this exhibit is used to its full potential. Most visitors stop at all illusions and experience them. They are all well explained and provide a good time for the visitor.</i>
2	1-8 Body Measurements	<i>This area, along with the wall opposite of it, is one of the highlights of Sportsworks. Children enjoy going along and doing all of the activities. The most popular are the jump measurement, balance board, and the height measurement. Like the visual illusion wall all of this is very well explained and there are no visible weaknesses.</i>
3	9-13 Body Fitness	<i>Of the two walls involved with the Sportspass, this is the more popular one. Children love testing their strength on the pull rope, hitting the buttons for hand eye coordination and doing the step up drill to measure their heart rate. The only part that takes a little bit for most visitors to understand is the peripheral vision part- many do end up getting it in the end, but it just takes a little longer.</i>
4	Sportspass Quiz	<i>In all of our observation hours we rarely saw someone filling out the Sportspass on the computer. Some children would fill out the paper sheet, but they would not transfer it into the computer display.</i>
5	Water Sports	<i>The visitors did not have that many interactions with this exhibit. Many small children enjoyed getting in kayak and putting on the life jackets. Some other visitors would watch the swimming videos, but the other displays would rarely get looked at. The display about paddles was almost never visited. Most visitors would use this area to cut through to the more interactive displays.</i>
6	Sports Safety	<i>This is another exhibit that often gets passed by. Mostly it is given a passing glance while on the way to a more exciting exhibit like the race or the bike that you can pedal to see the skeleton mirror your movements. If a visitor does stop here then it is usually to play with the different kinds of joints.</i>
7	Sports Equipment	<i>The pathway where this exhibit sits is often traversed. The parts that often draw the visitor's attention are the wall with all of the different sports balls and the bike pedals that are connected to the skeleton riding the bike hanging above the exhibits. The displays are often not read.</i>
8	Snow Sports	<i>The main attraction here is the snowboarding simulator. It is visited very often and many visitors enjoy watching themselves snowboard down the mountain. It should be noted that the display of skis and snowboards does not ever get looked at.</i>
9	Rock Wall	<i>The rock wall is a big attraction for children of all ages and provides them with something to do while they are waiting to do the race. Similar to the</i>

		<i>snow sports exhibit, the small display with rock climbing gear rarely ever gets looked at.</i>
10	Race	<i>By far the race is the most popular part of Sportsworks. Children love running up and down the track. Unfortunately the concept of running against Cathy Freeman has gone to waste, as many children do not understand that you have to wait for the gun sound to go off before you go. Most children end up beating Freeman because they leave very early. It would be helpful if the announcer said "Ready, set, go," or if the gun went off immediately after set. Even though this is not as accurate to a real life race, the exhibit would be used more appropriately. Another thing that should be noted is that when the button gets pushed to many times in succession the exhibit gets all messed up and not in sync.</i>
11	Soccer Goalie	<i>This exhibit was broken the whole time we were observing so there is nothing to report here.</i>
12	Wheelchair Race	<i>This is another very popular part of Sportsworks. There are usually large crowds gathered around the screen waiting their turn to try. There is nothing much to report here other than the fact that it is a well loved exhibit that continues to draw a lot of visitors. The only problem is that children often don't realize that they must turn both wheels at the same time for them to go faster.</i>
13	Interactive Sports	<i>All three sections which involve throwing or shooting a ball all get a lot of coverage. Children seem to enjoy the baseball, netball and Aussie rules football sections all equally. The only weak areas are in the baseball section. The trying to catch the ball with one eye closed activity rarely works for small children because they cannot get the ball up to point where it will drop down from. It just becomes a game of try to get the ball up on the shelf by throwing it. Also it has been observed that visitors rarely look at the cricket display where you have to decide whether it is an out or not. It does get some attention, but not as much as the more interactive areas.</i>
14	Gymnastics	<i>This exhibit gets a lot of quick coverage. That means that many visitors will stop at this exhibit, but only for a minute or two. They will watch part of the gymnastics routine, but not the whole thing. Some do stay for the whole time to put scores in, but not many. People will also walk across the balance beam.</i>

Miscellaneous Exhibits and Temporary Exhibition

Exhibition Name	Observations
Science Stage Outside Wall	<i>These small displays are often a stopping point for families on their way to Sportsworks. The two that get used the most are the Newton's Cradle and the pipes, which you can listen to your inner ear. They do garner quite a bit of interest for the families who do walk by them.</i>
Melbourne Planetarium Lobby	<i>Families often spend time in here after a planetarium show or will walk in to take a quick glance of what is there. Children enjoy the black hole demonstration and the model of the galaxy, which they can watch the planets move around the sun. Many children are also attracted to star model hanging on the wall that is a part of the exhibit in Sweden. Unfortunately they just touch and do not understand the significance of it being there, as some parents do not explain it to them. The other displays that are in glass casing in the room rarely get looked at.</i>
Alice's Wonderland Temporary Exhibition	<i>Children generally seem to love this whole exhibition. They especially enjoy crawling through the tunnel to get into exhibition hall and exploring the illusion room. Another highlight are the puzzles where you roll the ball down and try to get it into the hole. Most of this exhibition seems to work and be understood by all. It should be noted that signage plays a huge role in drawing visitors here. The huge Alice's Wonderland sign outside the entrance draws children to the room right away, whereas a blank wall would do nothing.</i>

Appendix F: Tracking Data

The tracking team completed twenty-one whole of site visitor tracks at Scienceworks. During each track, one member of the tracking team would record the time spent at exhibits and the other would hand draw visitor pathways onto maps. Both members of the team kept track of the interactions that visitors had with the exhibits and wrote down notable comments.

At the completion of each track, the tracking instrument was filled in. Demographic information, timing for large areas, exhibitions, and exhibits were recorded, in combination with interactions and notes.

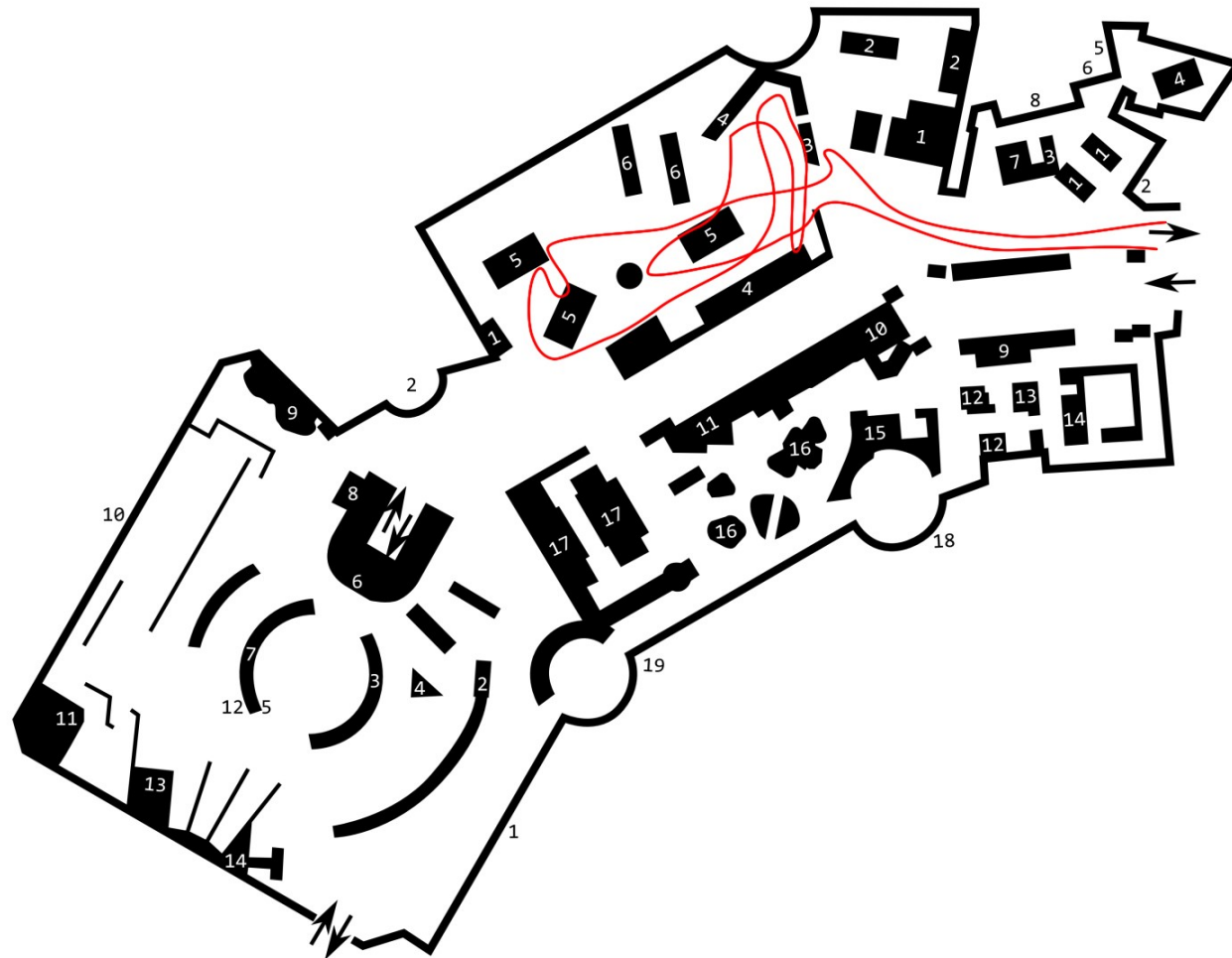
Our findings and conclusions are based off our tracking data. We frequently referred to our tracking instrument in order to determine specific instances of visitors interacting (or not interacting) with particular exhibits.

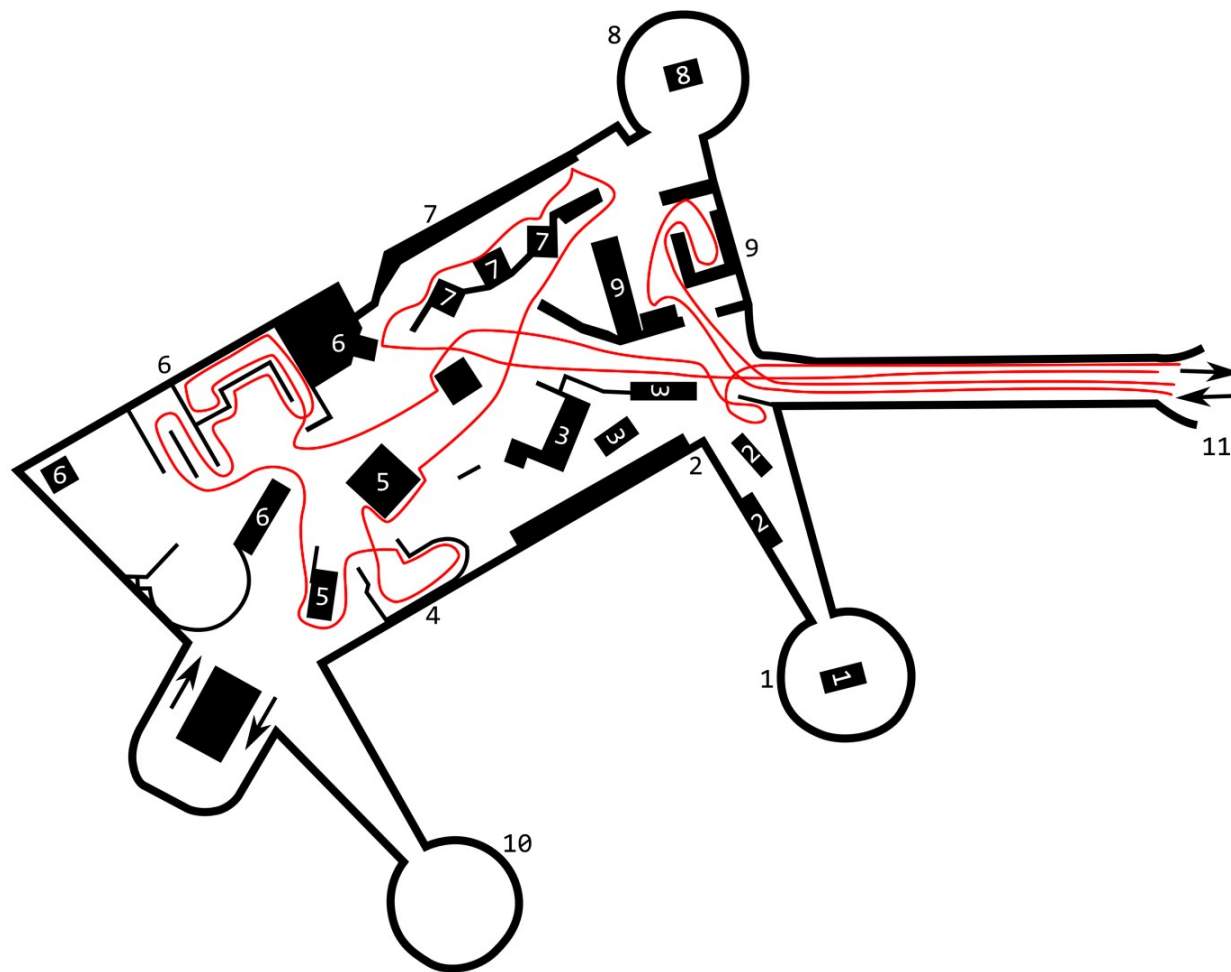
Below are the completed tracking instruments and maps for each of the twenty-one tracks. At the end of the Appendix is an overlay of all twenty-one tracks for both floors at Scienceworks.

Track 1

Visitor Track Number:						1
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/4/2015		Weekday:	Wednesday		
Description:	Young boy with a lot of energy					
Individual Demographics:	Gender:	Male	Attitude:	Excited		
	Age:	4				
Group Demographics:	# adults:	1	Leader:	Child		
	#children:	2(1 baby)	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:49					
TEG	10:52	11:09	0:17	4	0:03	Lots of social play in this section, bathroom stop on way to CAF
CAF	11:19	11:53	0:34		0:10	
BBQ	11:55	12:05	0:10		0:02	Generally played by himself
PLA	12:06	12:26	0:20		0:01	Play and social play, good conversation, convinced to play with school kids
NGC	12:28	12:39	0:11	1	0:02	
NGC	12:43	13:30	0:47	8	0:04	Lots of good interaction
SHP	13:31	13:48	0:17		0:01	
EXT		13:48			0:00	
Total Time		2:59		13		

Visitor Track Number							T R P A O P S W																					
Code							P P T L L O A B E O D O R T H O A H																					
							U U U I E U R O A H I C D E E O C T E																					
Exhi bit	Exhib it #	Time in	Time out	Durati on	Optim al Time	Transit Time	S	L	R	F	G	C	M	D	T	I	N	O	C	A	X	T	P	C	A			
							H	L	N	T	S	H	S	Y	E	T	T	N	O	D	T	O	L	H	R	Notes:		
TEG	3	10:52	10:53	0:01			8																					
TEG	5	10:54	11:00	0:06		0:01								1	1				1		1				2		Ran there, interacted with many school kids, rolled the ball several times	
TEG	4	11:00	11:05	0:05		0:00			2		1	3							1		1						Looked at 3 doors, ran around mirror display, corgos with mom a lot, has mom look at what he is looking at	
TEG	5	11:05	11:09	0:04		0:00			3		1		1						4	1					2		Gave ball to other kid, kept turning wheel for a long time, mom picked up kid to go to bathroom led to kid crying a little	
NGC	9	12:29	12:38	0:09							12		3		1	1			1		2				1	1	1	Played piano, then sat on mom's lap and played piano, lifted panels, interacted with girl same age
NGC	6	12:44	12:51	0:07	0:05															1						1	Operated exc avator, mom very involved	
NGC	7	12:51	12:58	0:07	0:04	0:00	1			2																1	Turned both wheels many times, watched video at the end	
NGC	5	12:58	13:01	0:03		0:00	11												11			4					Ran to Legos, lots of pointing, talking with mom (Lego city)	
NGC	4	13:01	13:08	0:07		0:00		1	10	3											1					1	Turned many wheels on boats	
NGC	5	13:08	13:08	0:00		0:00						1															Sat on bike	
NGC	6	13:09	13:26	0:17	0:05	0:01		2	3	6	1					1									2		Built wall with another kid and later on with several kids from school group, lots of running	
NGC	5	13:26	13:26	0:00		0:00			2																		Turned wheels of clock	
NGC	2	13:27	13:30	0:03	0:04	0:01			1												1				2		Looked at both microscopes individually and with mother, he watched her	

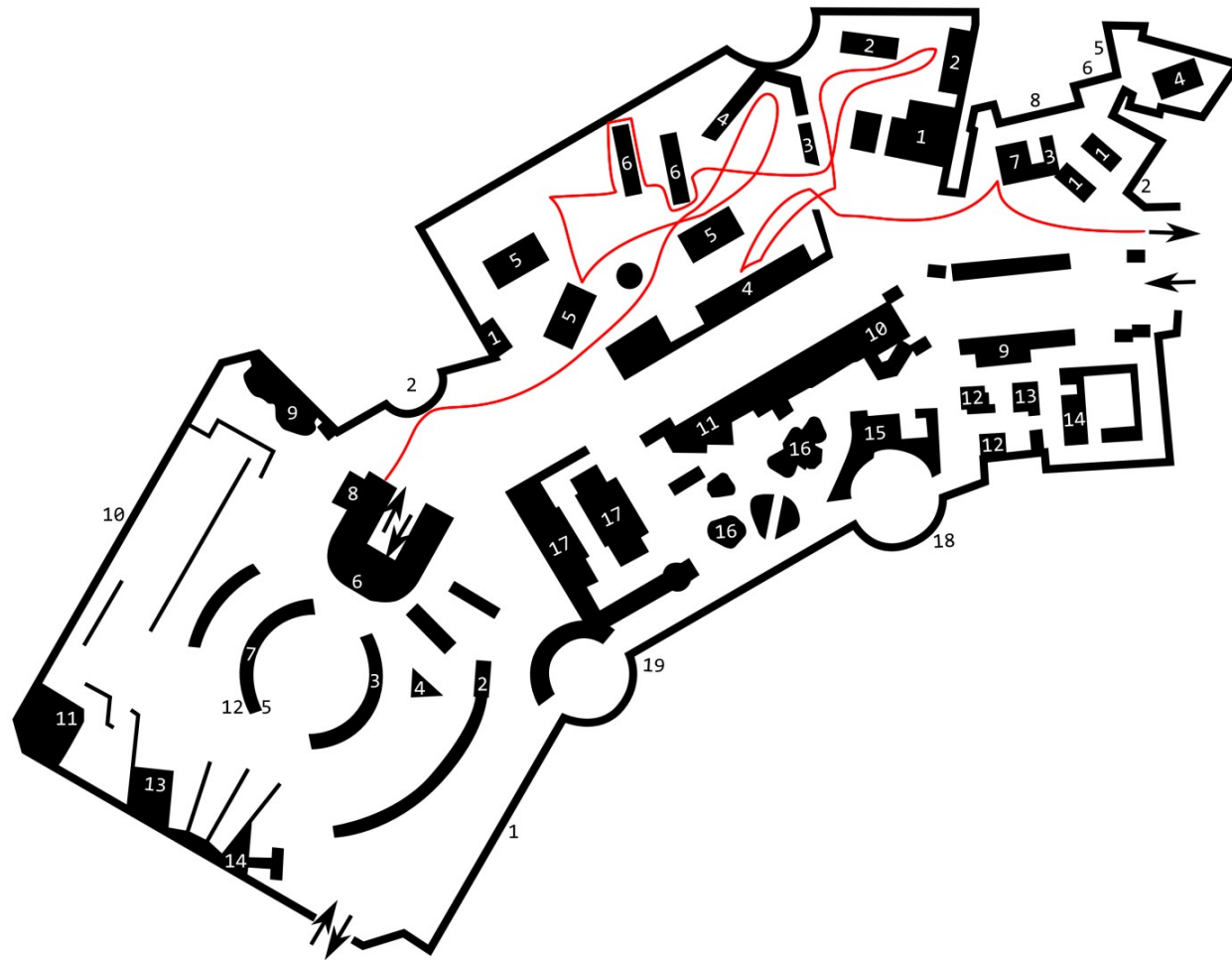


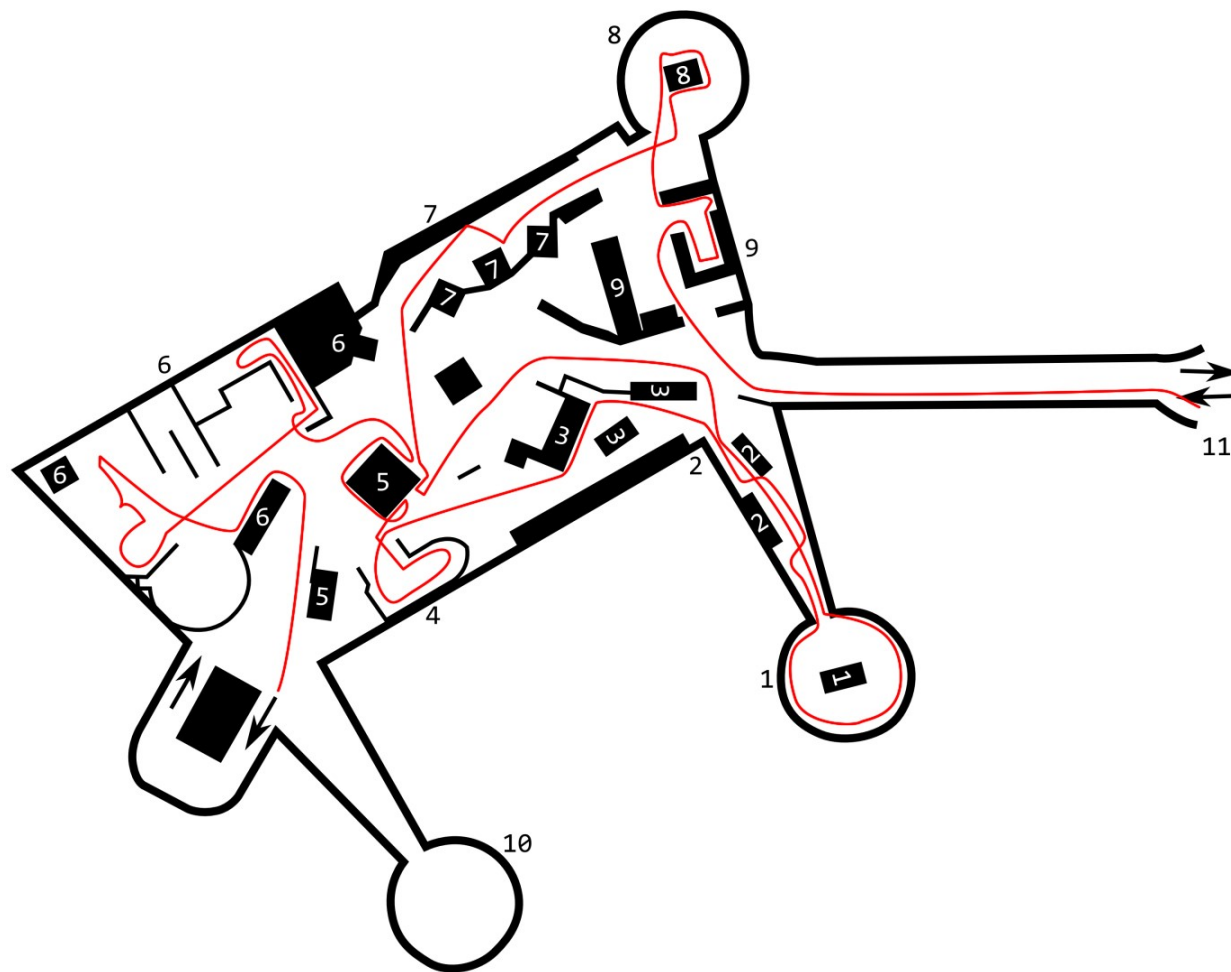


Track 2

Visitor Track Number:			2			
Investigator:	Michelle/Zach		Location:	Science works		
Date:	11/5/2015		Weekday:	Thursday		
Description:	Young boy, took a while to wake up and get energy. Was with his mom, grandma, and grandpa.					
Individual Demographics:	Gender:	Male	Attitude:	Precocious, quiet		
	Age:	3				
Group Demographics:	# adults:	3	Leader:	Adult and child switched		
	#children:	1	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:18					
NGC	10:20	11:30	1:10	11	0:02	Main interactions with grandma
SCS	11:32	11:32	0:00	1	0:02	
TEG	11:32	11:56	0:24	7	0:00	Lots of interactions with mom
THA	11:56	11:57	0:01		0:00	
EXT		11:57			0:00	Had hard time getting kid to leave, kept wanting to do more
Total Time		1:39		19		

THA	11	13:58	14:10	0:12							1		3	3	2			1	1	Did car thing multiple times
THA	17	14:10	14:10	0:00		0:00				2										Lifted 2 cans (gravity display)
THA	11	14:10	14:12	0:02		0:00					1		1							
SPW	10	14:13	14:15	0:02															1	
SPW	9	14:15	14:15	0:00		0:00						1								Climbed on wall
SPW	10	14:15	14:17	0:02		0:00			4										1	Watched race, didn't do it
SPW	8	14:17	14:19	0:02		0:00													1	Waited in line to do snowboard, didn't do it
SPW	5	14:19	14:20	0:01		0:00													1	
SPW	13	14:20	14:21	0:01		0:00					1								1	Threw ball once
SPW	2	14:22	14:23	0:01		0:01				1									1	
SPW	3	14:24	14:24	0:00		0:01					1								1	
SPW	2	14:25	14:27	0:02		0:01					2	1								
MPL	1	14:28	14:32	0:04					1		2								1	
SPW	12	14:32	14:35	0:03							1					1			1	Did wheelchair race with help from mom
SPW	8	14:36	14:38	0:02		0:01	2			1						1			1	Tried snowboard
SPW	10	14:38	14:41	0:03	0:01	0:00	4					1						1	1	Only did race once
SPW	9	14:41	14:42	0:01		0:00						1								
SPW	10	14:42	14:43	0:01	0:01	0:00	1												1	
SPW	8	14:43	14:43	0:00		0:00				1									1	
SCS	1	14:43	14:44	0:01							1								1	
TEG	5	14:46	14:47	0:01					1			1							1	
TEG	6	14:47	14:51	0:04		0:00	5	3	6	2					1					Pushed dishes through right holes
TEG	5	14:51	14:52	0:01		0:00			1										1	
TEG	6	14:52	14:54	0:02		0:00			2	4					1					



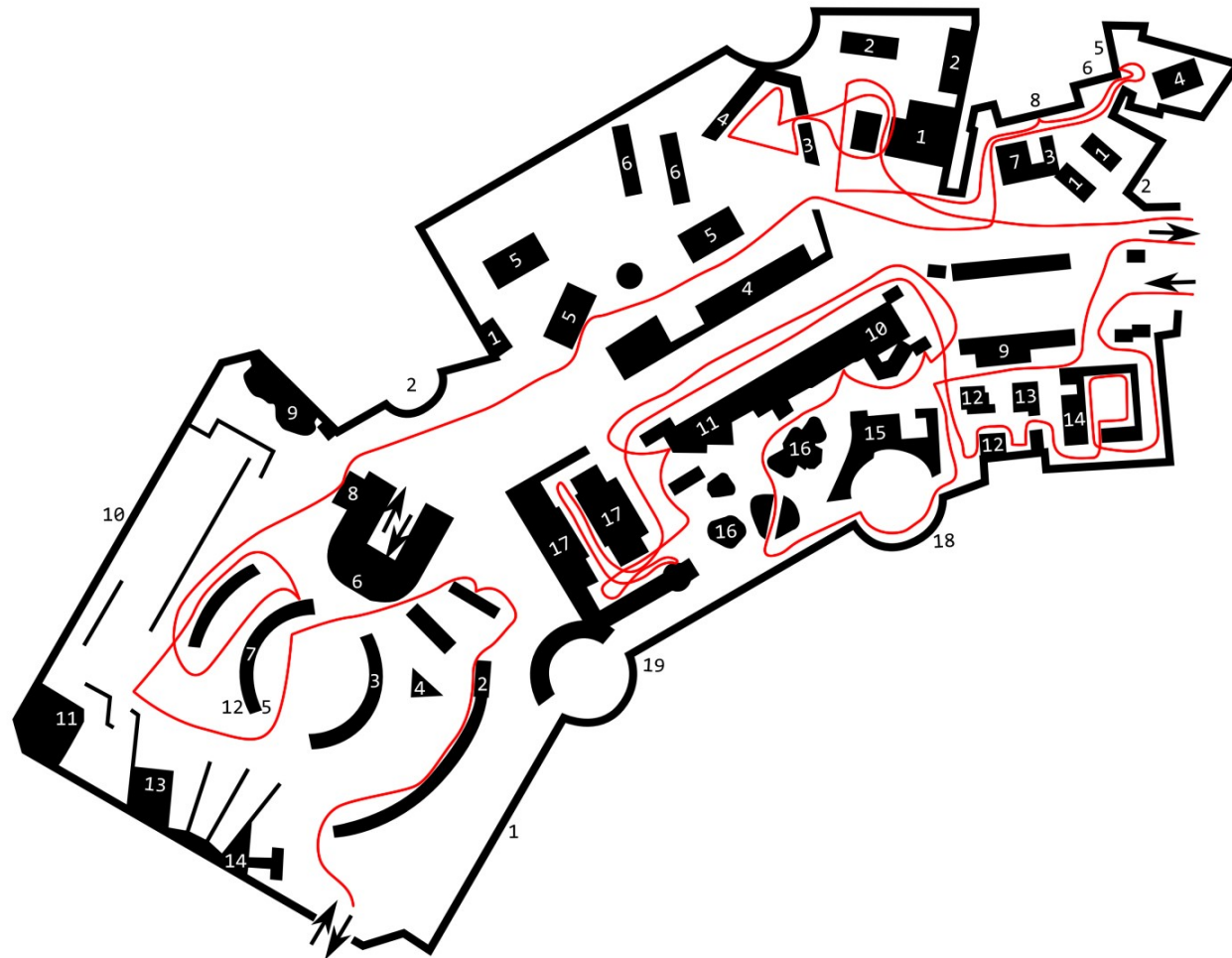


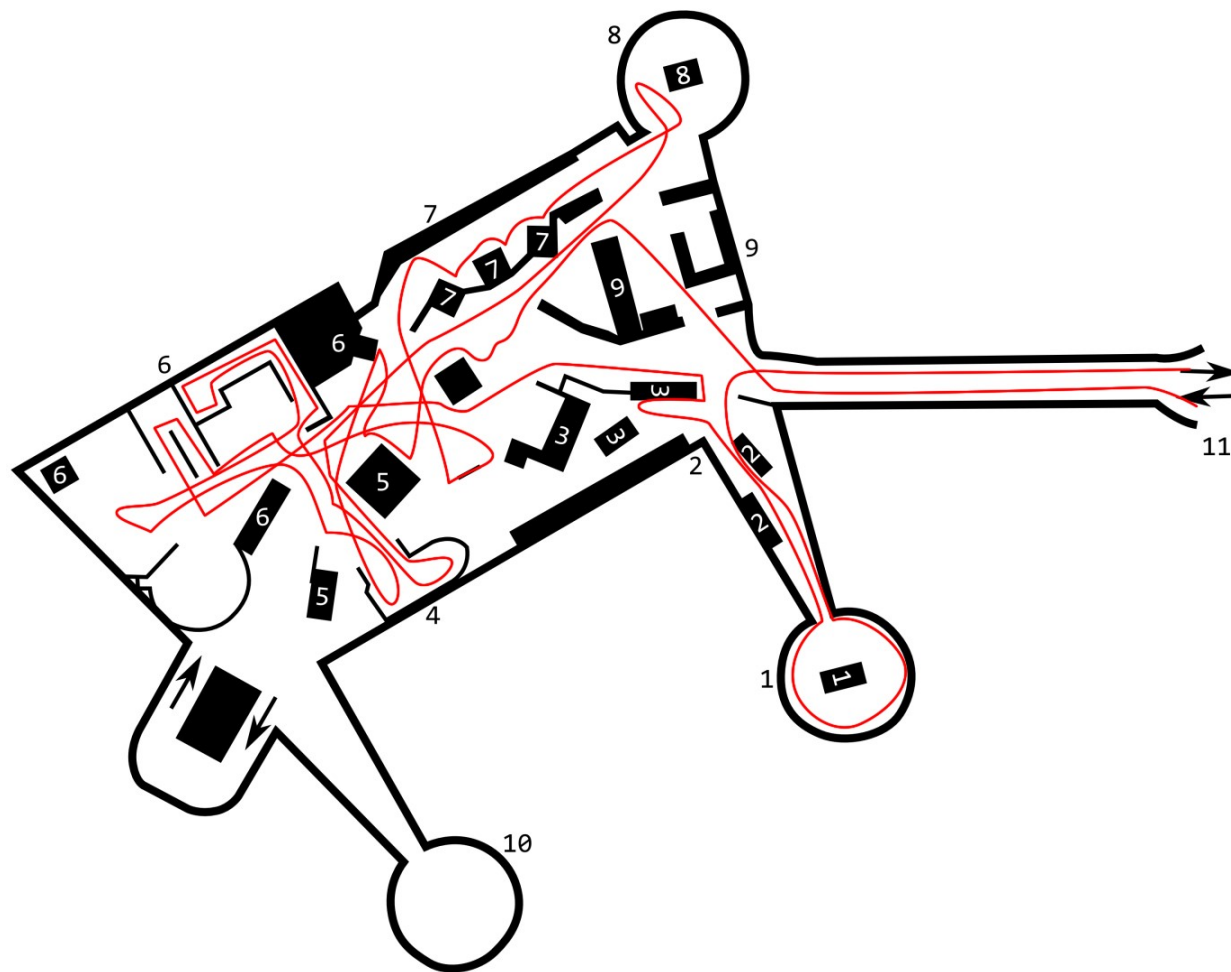
Track 3

Visitor Track Number:			3			
Investigator:	Zach/Michelle		Location:	Scienceworks		
Date:	11/5/2015		Weekday:	Thursday		
Des cription:	Young girl with a lot of energy at Scienceworks with her family for what seemed to be the first time. She was with her dad, mom, and younger brother who was in a stroller.					
Individual Demographics:	Gender:	Girl	Attitude:	Hyper, curious		
	Age:	5				
Group Demographics:	# adults:	2	Leader:	Both		
	#children:	2	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	12:39					
TKS	12:39	12:42	0:03		0:00	
NGC	12:43	13:09	0:26	12	0:01	Moves around in a quick and bouncy way. Never spent too long at an exhibit
TEG	13:11	13:13	0:02	2	0:02	
THA	13:14	13:16	0:02	3	0:01	
TEG	13:17	13:18	0:01	1	0:01	
SPW	13:18	13:24	0:06	5	0:00	More parent led section
MPL	13:25	13:26	0:01	1	0:01	
CAF	13:28	13:50	0:22		0:02	
THA	13:56	14:13	0:17	7	0:06	
SHP	14:13	14:17	0:04		0:00	
EXT		14:21			0:04	
Total Time		1:42		31		

sitor Track Number		3		T R P A O P S W																			
Code		P P T L L O A B E O D O R T H O A H																					
		U U U I E U R O A H I C D E E O C T E																					
		S L R F G C M D T I N O C A X T P C A																					
		H L N T S H S Y E T T M O D T O L H R																					
		Notes:																					
Exhi bit	Exhi bit #	Time in	Time out	Durati on	Optim al Time	Transit Time																	
NGC	5	12:45	12:45	0:00																			
NGC	6	12:45	12:48	0:03	0:05	0:00																	
NGC	4	12:48	12:49	0:01		0:00																	
NGC	6	12:50	12:55	0:05	0:05	0:01		8	1	3													
NGC	4	12:56	12:56	0:00		0:01		1															
NGC	8	12:57	12:58	0:01		0:01																	
NGC	7	12:58	12:59	0:01	0:04	0:00	2		3														
NGC	3	13:00	13:01	0:01		0:01																	
NGC	6	13:02	13:03	0:01	0:05	0:01																	
NGC	3	13:03	13:04	0:01		0:00																	
NGC	1	13:04	13:07	0:03		0:00																	
NGC	11	13:08	13:09	0:01		0:01	1																
TEG	1	13:11	13:12	0:01																			
TEG	4	13:12	13:13	0:01		0:00			2														
THA	8	13:14	13:15	0:01																			
THA	2	13:15	13:16	0:01		0:00			1														
THA	6	13:16	13:16	0:00		0:00																	
TEG	5	13:17	13:18	0:01																			
SPW	8	13:18	13:18	0:00																			
SPW	10	13:19	13:19	0:00	0:01	0:01																	
SPW	6	13:20	13:20	0:00		0:01																	
SPW	5	13:20	13:21	0:01		0:00																	
SPW	2	13:22	13:24	0:02		0:01																	

MPL	1	13:25	13:26	0:01																No interactions, just walked around a little
THA	14	13:56	13:58	0:02	0:02					1		1			2				1	Played with touch screen with mom
THA	12	13:58	14:04	0:06	0:02	0:00						1	1		1				1	Did activity, watched mom do it
THA	17	14:05	14:08	0:03		0:01		1						1						
THA	11	14:08	14:09	0:01		0:00				1		1			1					Started to make car with mom
THA	10	14:09	14:11	0:02		0:00				2						1				
THA	16	14:11	14:11	0:00		0:00				1					1	1				Read some exhibits with mom
THA	18	14:12	14:12	0:00		0:01				1					1					

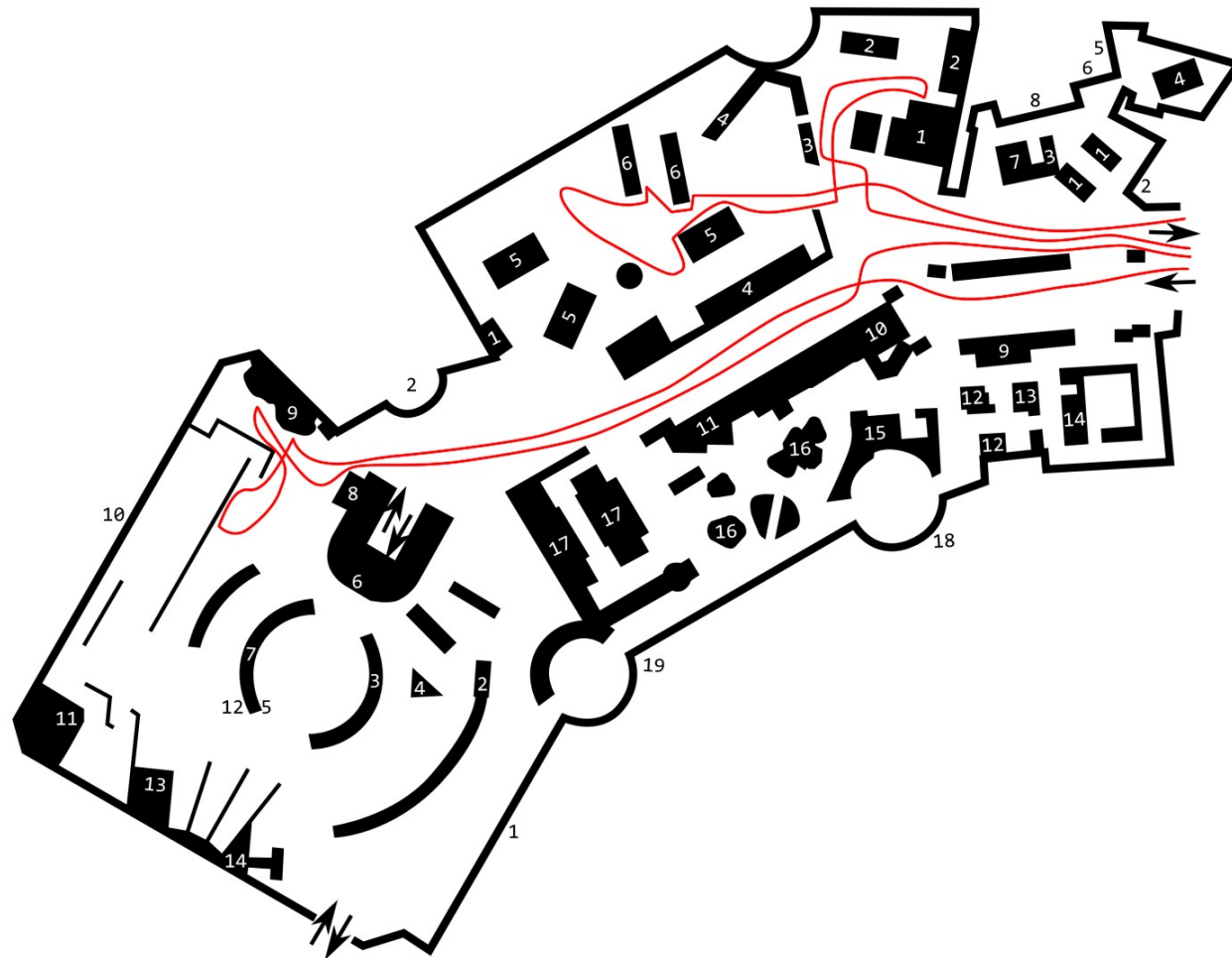


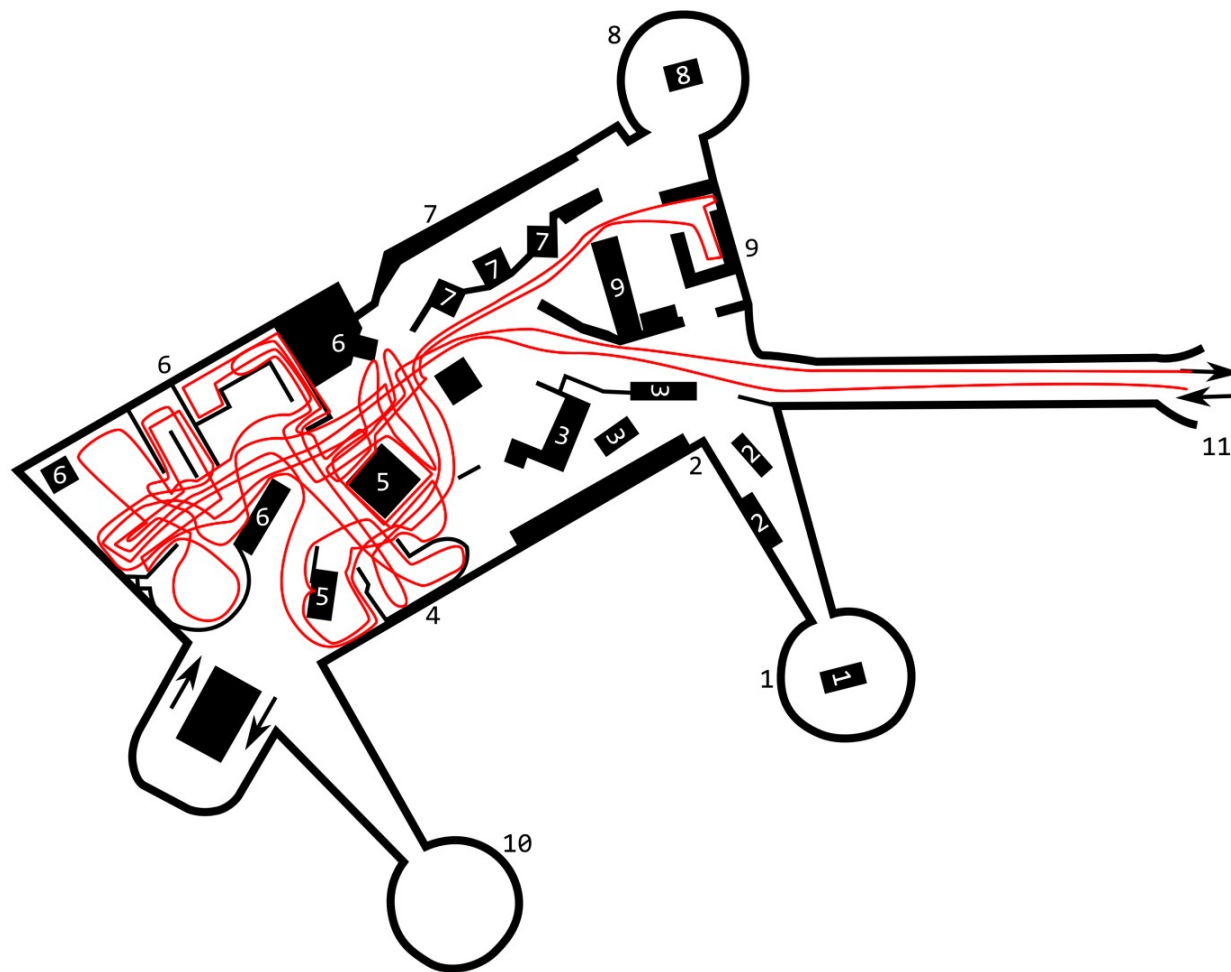


Track 4

Visitor Track Number:			4			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/6/2015		Weekday:	Friday		
Description:	Young girl with mom, baby sibling, friend, friend's younger sibling, and friend's mom					
Individual Demographics:	Gender:	Female	Attitude:	Shy		
	Age:	4				
Group	# adults:	2	Leader:	Both		
Demographics:	#children:	4	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:05					
TEG	10:07	10:12	0:05	5	0:02	
NGC	10:14	11:08	0:54	17	0:02	
SPW	11:12	11:17	0:05	3	0:04	
PLA	11:20	11:51	0:31		0:03	Had snack/Social play on playground
CAF	11:53	12:14	0:21		0:02	Girl acted out and cried
EXT		12:16			0:02	
Total Time		2:11		25		

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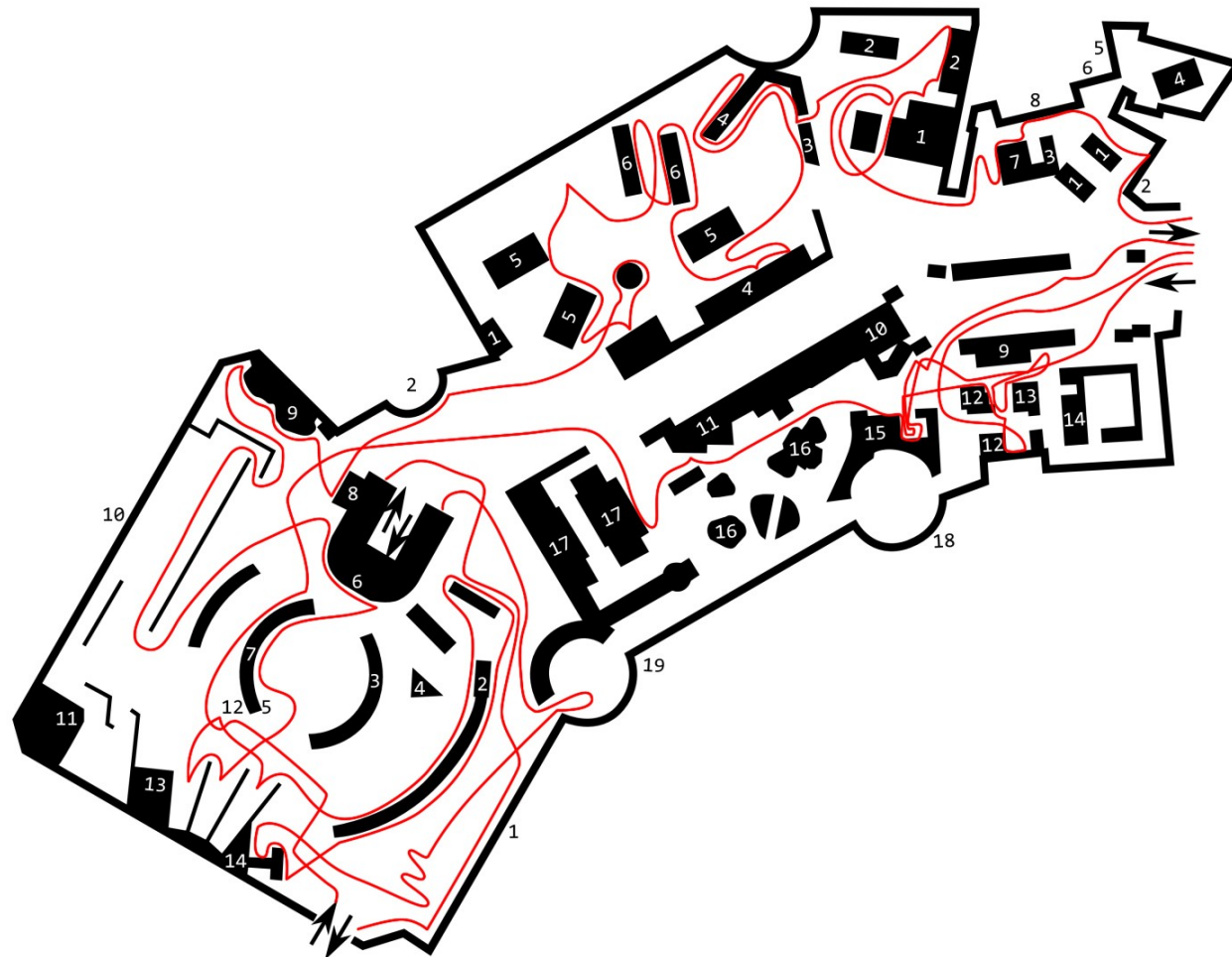


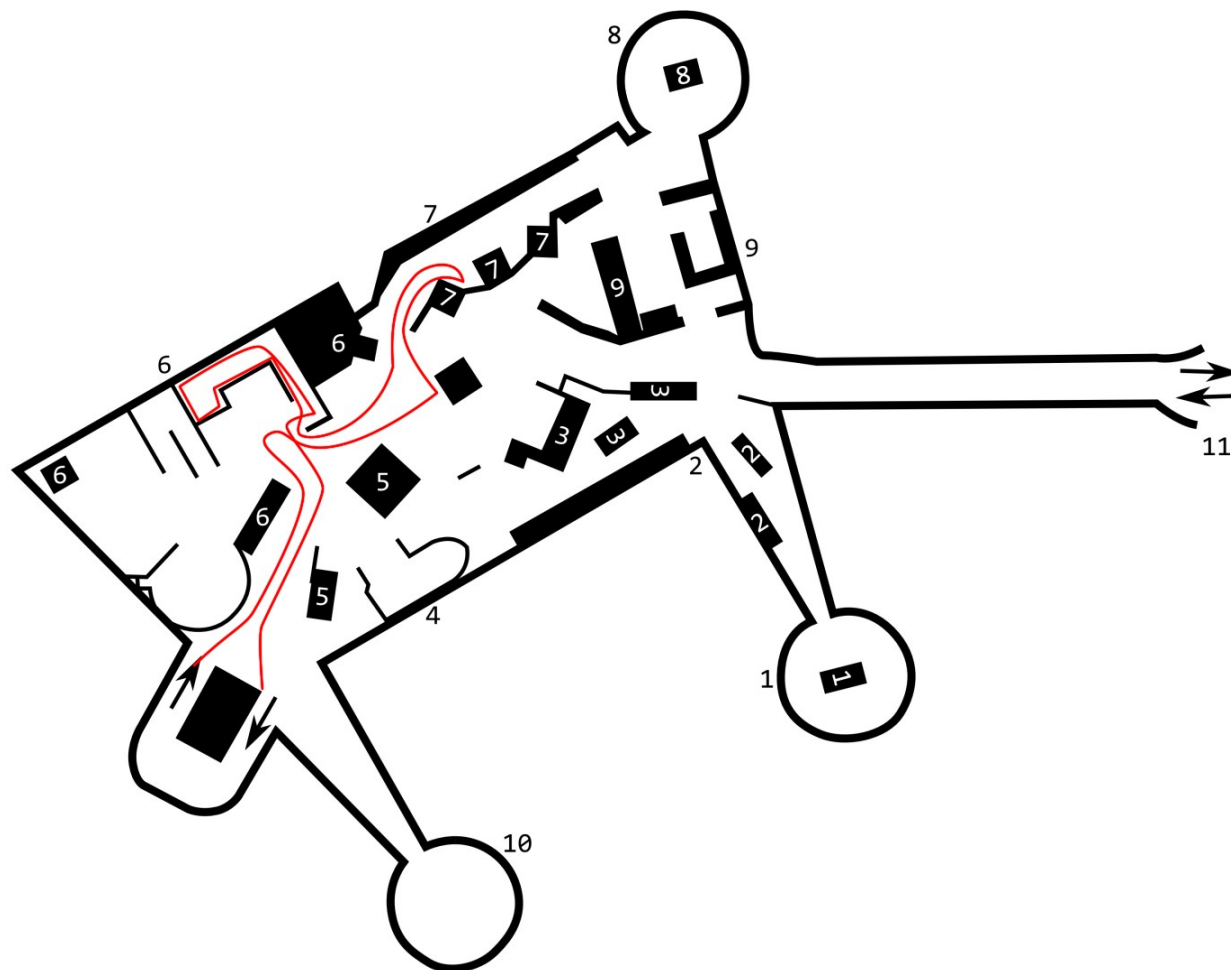
Track 5

Visitor Track Number:						5
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/6/2015		Weekday:	Friday		
Description:	With dad, looks like its their first time. Dad seemed VERY interested in helping his daughter learn. Had great conversations throughout the whole visit.					
Individual Demographics:	Gender:	Female	Attitude:	Excited, energetic		
	Age:	7				
Group Demographics:	# adults:	1	Leader:	Father		
	#children:	1	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	12:55					
THA	12:58	13:13	0:15	5	0:03	Dad very involved
TEG	13:13	13:43	0:30	8	0:00	Did a lot in this area
SCS	13:44	13:46	0:02	1	0:01	
SPW	13:46	14:18	0:32	12	0:00	Very interested in all exhibits
NGC	14:19	14:23	0:04	3	0:01	
MPL	14:25	15:21	0:56		0:02	Waited in line, looked around a little after show
SPW	15:22	15:26	0:04	2	0:01	
THA	15:27	15:42	0:15	5	0:01	Went to get drink between two think ahead visits
THA	15:44	15:55	0:11	2	0:02	
EXT		15:56			0:01	
Total Time		3:01		38		

Code		Track 5					T R P A O P S W																Notes
Exhib it	Exhi bit #	Time in	Time out	Duratio n	Transit Time	P P T L L O A B E O D O R T H O A H																	
						U U U I E U R O A H I C D E E O C T E																	
						S L R F G C M D T I N O C A X T P C A																	
						H L N T S		H S Y E T		N O D		T O L		H R									
THA	2	12:58	13:00	0:02			1					1	1	1				Talked with Dad, he read meanings to her					
THA	3	13:00	13:01	0:01	0:00				1				1	1				Talked with Dad					
THA	8	13:01	13:06	0:05	0:00				1		1		2					Figured out city display with Dad.					
THA	7	13:06	13:07	0:01	0:00				1				1	1				Dad explaining exhibit to her. She is looking and shaking her head that she understands.					
THA	8	13:07	13:13	0:06	0:00		1		2		1		2				2	Listened to Dad intently					
TEG	1	13:13	13:16	0:03			1				1				1			Crawled through tunnel, Dad explaining howto do stuff without doing it himself (globe)					
TEG	3	13:16	13:17	0:01	0:00		5											Word wheels					
TEG	3	13:17	13:20	0:03	0:00		4						1			1							
TEG	4	13:20	13:25	0:05	0:00		2	2					2					Looked at many doors. Dad looking with her after she called for him.					
TEG	5	13:25	13:27	0:02	0:00					1						1	1	Several kids. Sitting and watching. Dad very encouraging when on her turn she makes the ball go in.					
TEG	4	13:27	13:28	0:01	0:00		2						2				2	Spun both illusions, dad asks if she sees the illusions					
TEG	6	13:28	13:39	0:11	0:00	15	1		2		1		3	1		1	2	Dad encouraging daughter, pushed dishes through correct slots, Reading what to do at clockspart. Looked at all exhibit parts.					
TEG	5	13:39	13:43	0:04	0:00		3		2	2			1					Took photo in small house display, turned middle picture matchup, rolled ball down 2 diff ramps					
SCS	1	13:44	13:46	0:02						1					2			1	1				
SPW	8	13:46	13:48	0:02							1			1				1	Tried snowboard				
SPW	9	13:48	13:50	0:02	0:00						3			1	1				Climbed rock wall 3 times in diff spots, dad took pic				
SPW	10	13:50	13:52	0:02	0:00						2						1		Ran race two times				
SPW	6	13:52	13:53	0:01	0:00	4							1	1					Put on life jacket				
SPW	5	13:53	13:54	0:01	0:00	1					1			1					Netball, threw baseball many times				
SPW	13	13:54	13:58	0:04	0:00						2			1					Did wheelchair race against young girl				
SPW	12	13:59	14:01	0:02	0:01						1								Threw Aussie rules football many times				
SPW	13	14:01	14:02	0:01	0:00						1			1					Visited all exhibit parts				
SPW	2	14:02	14:07	0:05	0:00	1			3	2	5			1	2	1			Visited all illusions				
SPW	1	14:07	14:13	0:06	0:00	1	6		3	2				3	2			2	Visited all illusions				

SPW	14	14:13	14:14	0:01	0:00				1							1				1	Walked on balance beam
SPW	1	14:14	14:18	0:04	0:00											1	2				
NGC	5	14:20	14:20	0:00				1													Touch and go
NGC	7	14:21	14:21	0:00	0:01			1												1	
NGC	6	14:22	14:23	0:01	0:01			1				1									Wall- very shortly there...needed to make Planetarium show
SPW	12	15:22	15:24	0:02							1										Did wheelchair race against dad
SPW	7	15:25	15:26	0:01	0:01				1							1					Rode bike with help from dad
THA	17	15:27	15:28	0:01				8	2							2	1				Lifted cans, dad explained
THA	11	15:28	15:32	0:04	0:00				1			1				2					
THA	12	15:32	15:38	0:06	0:00							2	2			1				1	Did cyborg creating twice, after watching dad do it once
THA	10	15:38	15:38	0:00	0:00				1												Sat on bike/scooter
THA	12	15:38	15:42	0:04	0:00				1		2	2									Did cyborg creating two more times
THA	9	15:44	15:45	0:01	15:44															2	
THA	12	15:45	15:54	0:09	0:00						3	3		1		1				2	Cyborg creating two/three more times
THA	10	15:55	15:55	0:00	0:01				1												



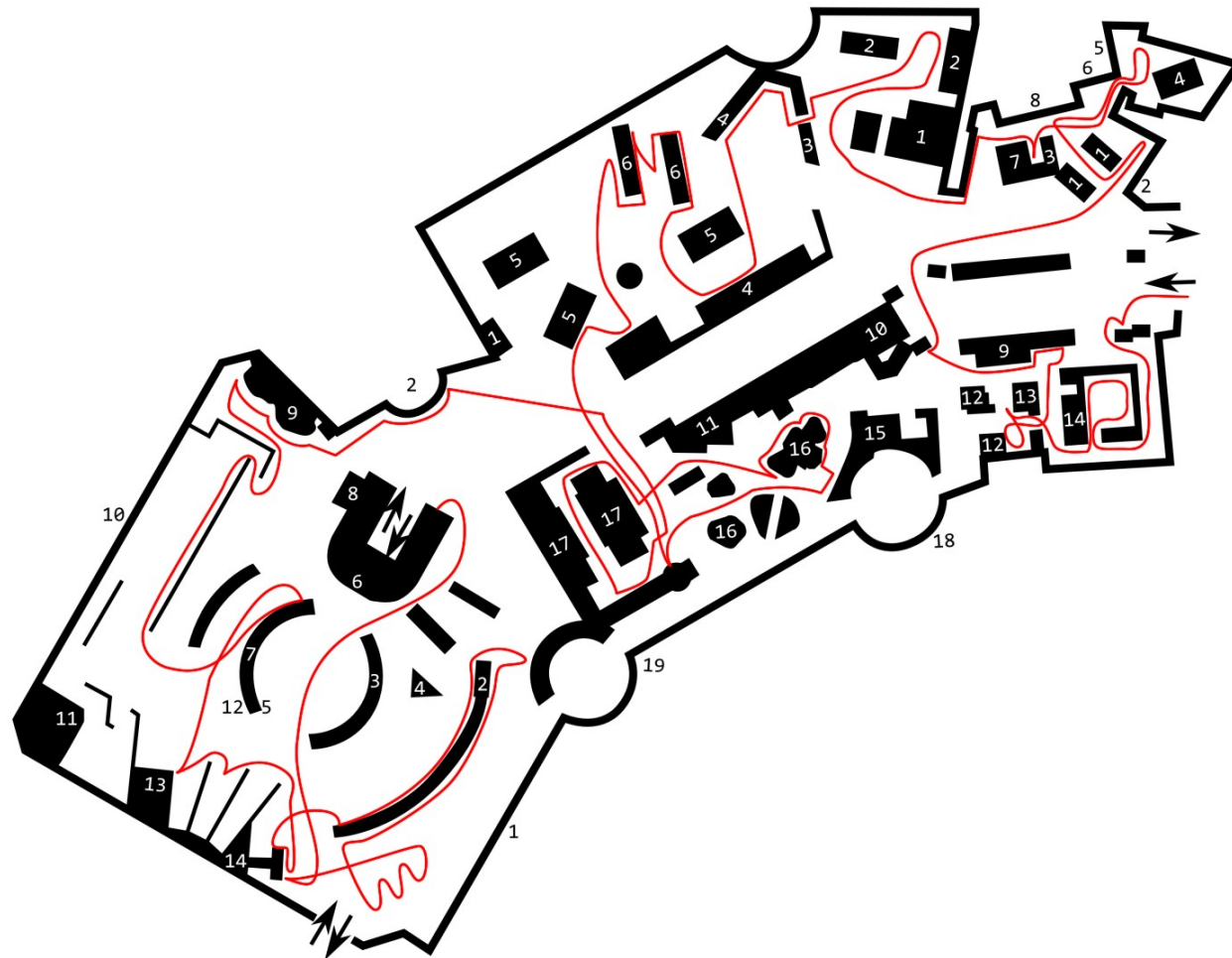


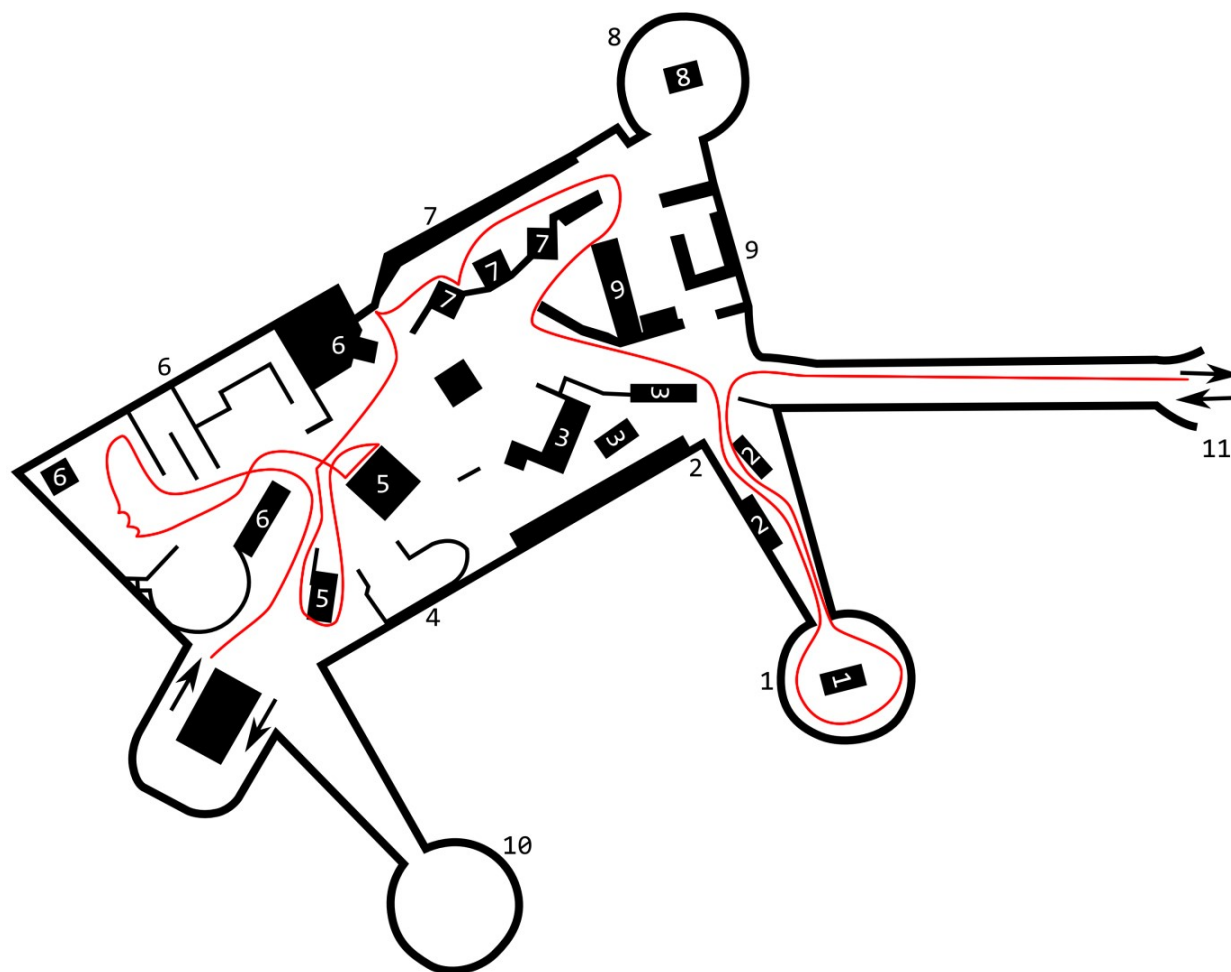
Track 6

Visitor Track Number:			6			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/8/2015		Weekday:	Sunday		
Description:	Two girls with babysitter					
Individual Demographics:	Gender:	Female	Attitude:	Calm/Indifferent		
	Age:	12				
Group Demographics:	# adults:	1	Leader:	Adult		
	#children:	2	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:38					
THA	10:44	11:03	0:19	12	0:06	Moved around quickly
TEG	11:03	11:12	0:09	6	0:00	
THA	11:13	11:19	0:06	3	0:01	
SCS	11:19	11:19	0:00	1	0:00	Stopped quickly and kept going
SPW	11:19	11:34	0:15	9	0:00	
NGC	11:36	11:44	0:08	4	0:02	
LGR	11:47	12:33	0:46		0:03	
CAF	12:34	12:54	0:20		0:01	
PST	13:01	13:26	0:25		0:07	
EXT		13:29			0:03	
Total Time		2:51		35		

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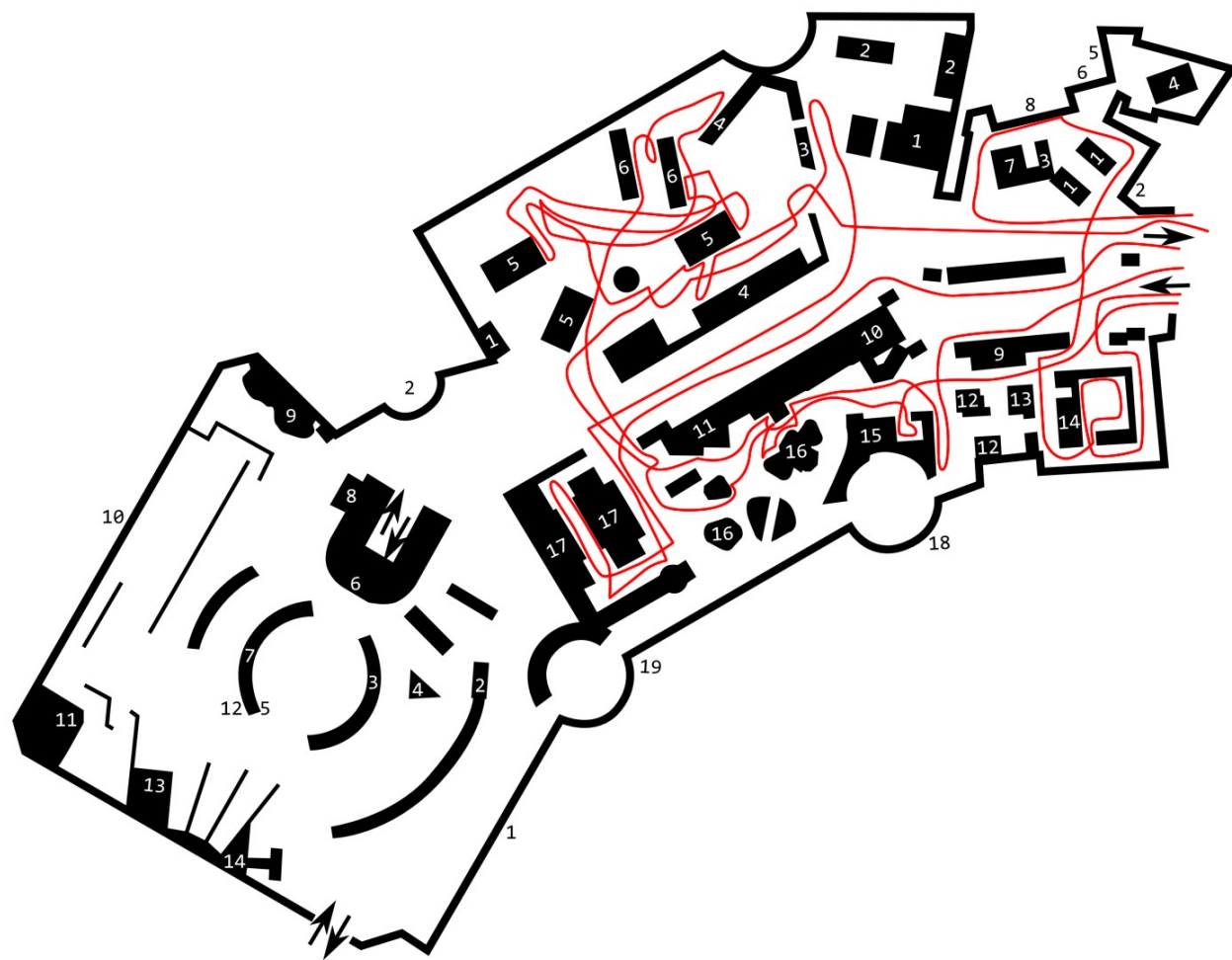


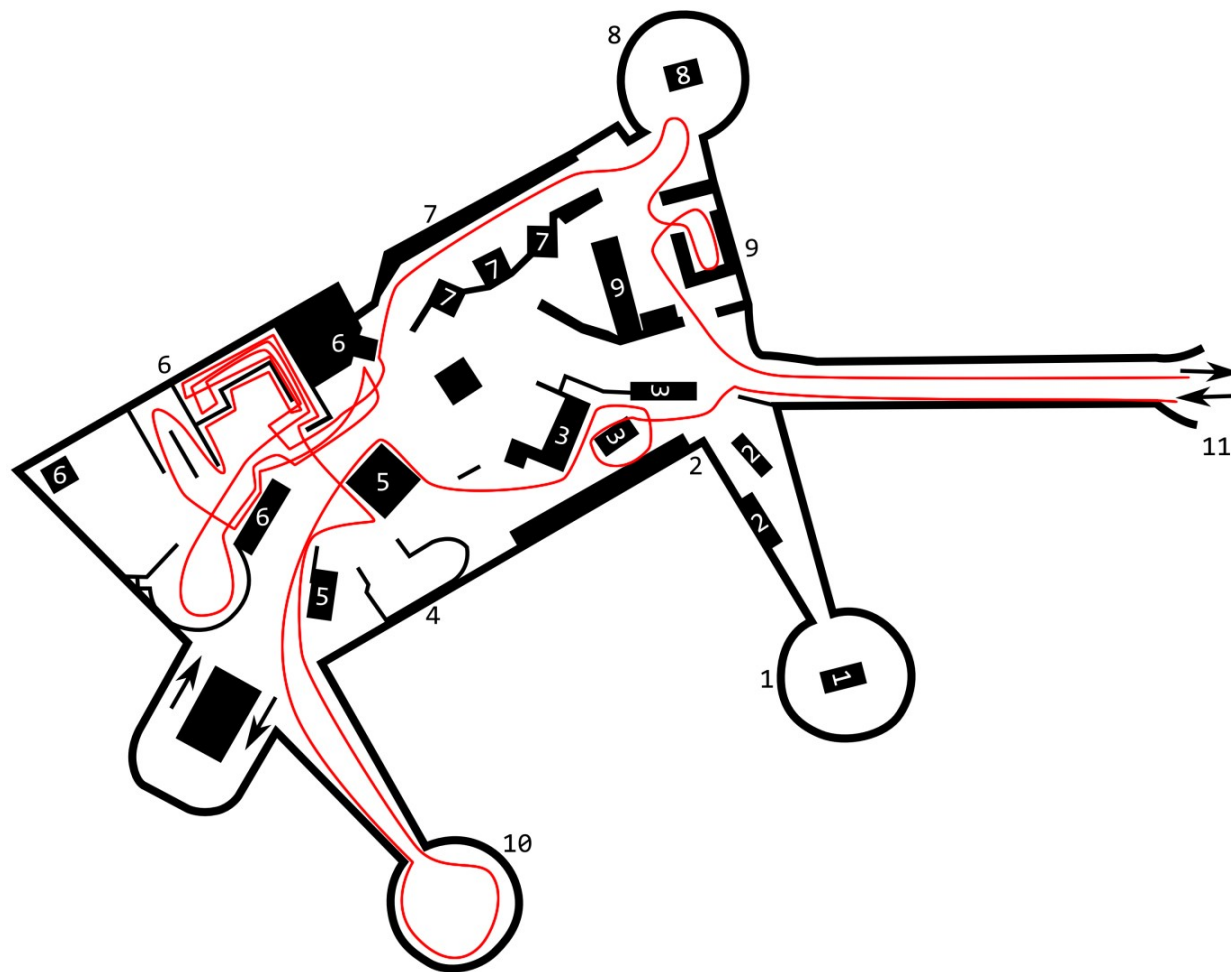


Track 7

Visitor Track Number:					7	
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/10/2015		Weekday:	Tuesday		
Description:	Young boy with father and younger brother, rides in stroller a lot more than younger brother. Father tends to take boys away from the crowded areas. Dad let the boys go where they wanted.					
Individual Demographics:	Gender:	Male	Attitude:	Somewhat excited		
	Age:	4				
Group	# adults:	1	Leader:	Dad		
Demographics:	#children:	2	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:02					
THA	10:04	10:11	0:07	3	0:02	
TEG	10:11	10:17	0:06	2	0:00	
THA	10:18	10:22	0:04	1	0:01	After this they went for a snack and bathroom break in main lobby
THA	10:36	10:43	0:07	2	0:14	Dad leads the way, only seems to highlight big exhibits
NGC	10:44	11:26	0:42	7	0:01	
CAF	11:29	11:48	0:19		0:03	
THA	11:50	12:07	0:17	7	0:02	
TEG	12:08	12:35	0:27	6	0:01	
EXT		12:38			0:03	
Total Time		2:36		28		

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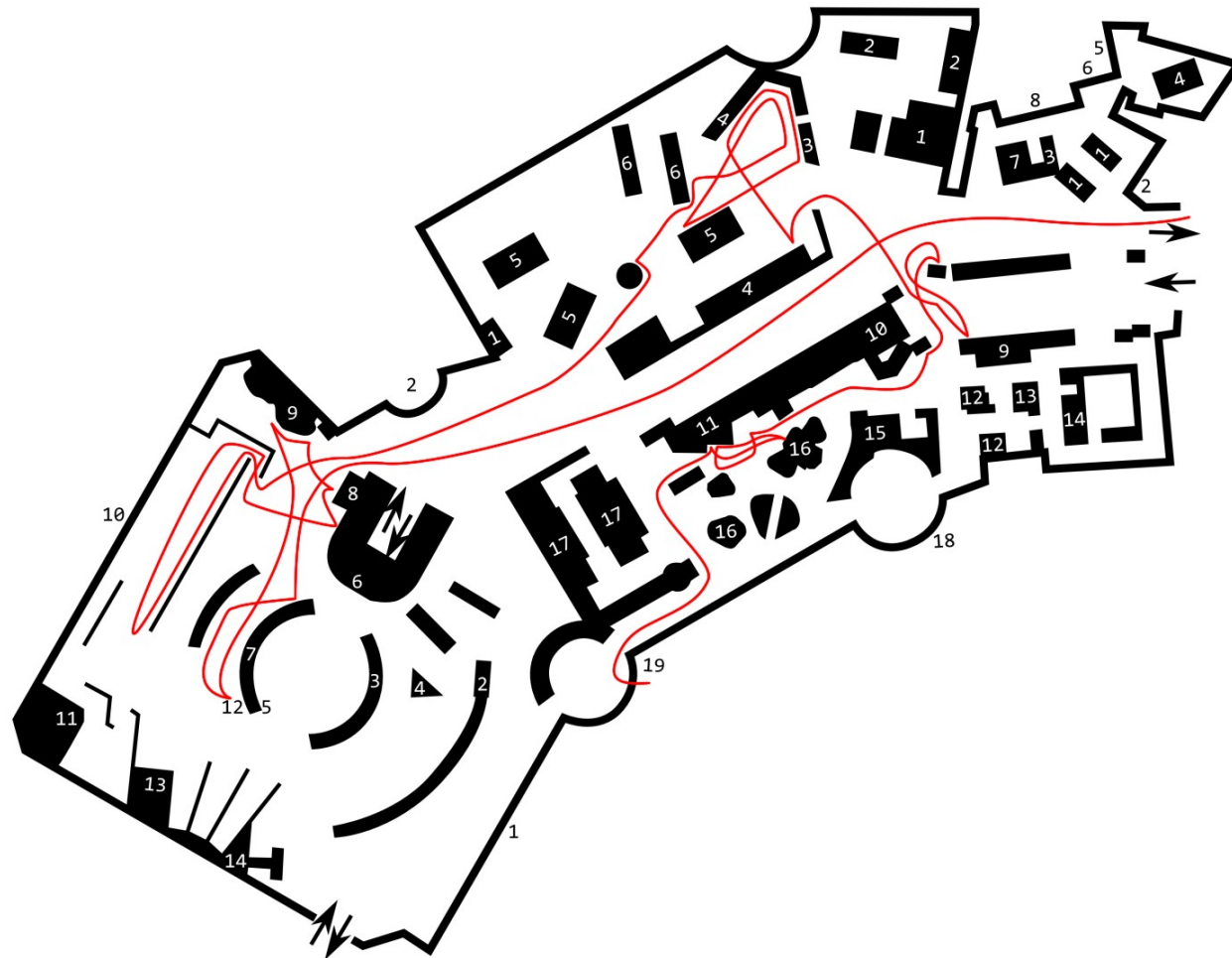


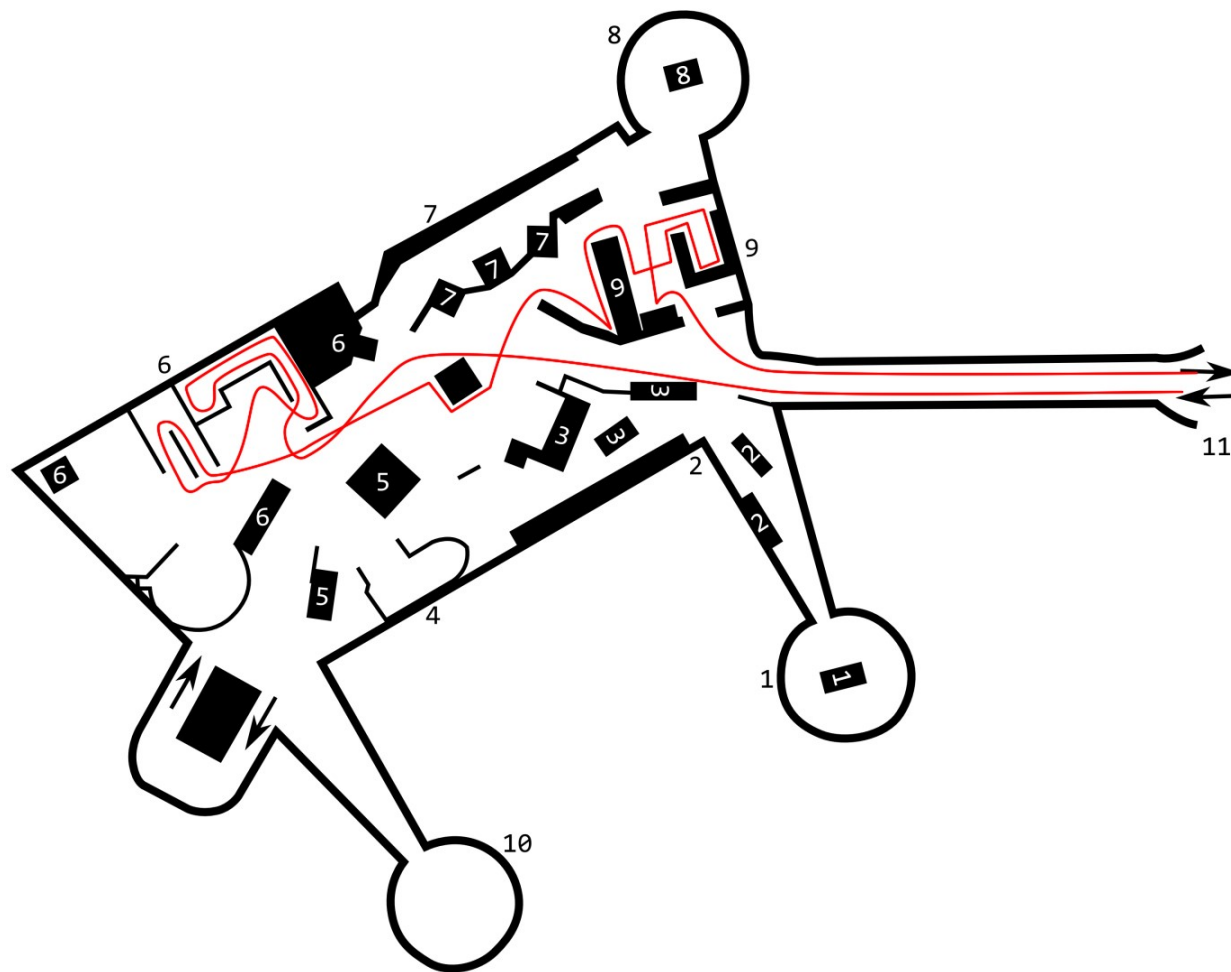


Track 8

Visitor Track Number:				8		
Investigator:	Michelle/Zach		Location:	Science works		
Date:	11/10/2015		Weekday:	Monday		
Description:	Young girl with brother, friend, and friend's mom. The caretaker allowed the children to go where they wanted and the children split up to different exhibits if they desired.					
Individual Demographics:	Gender:	Female	Attitude:	Excited		
	Age:	6				
Group Demographics:	# adults:	1	Leader:	Child		
	#children:	3	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	12:54					Often pulled from place to place
AMP	12:59	13:04	0:05		0:05	
PLA	13:04	13:06	0:02		0:00	
THA	13:07	13:22	0:15	4	0:01	
TEG	13:22	13:31	0:09	5	0:00	
SPW	13:31	13:39	0:08	5	0:00	Very social
NGC	13:46	14:04	0:18	3	0:07	
EXT		14:07			0:03	
Total Time		1:13		17		

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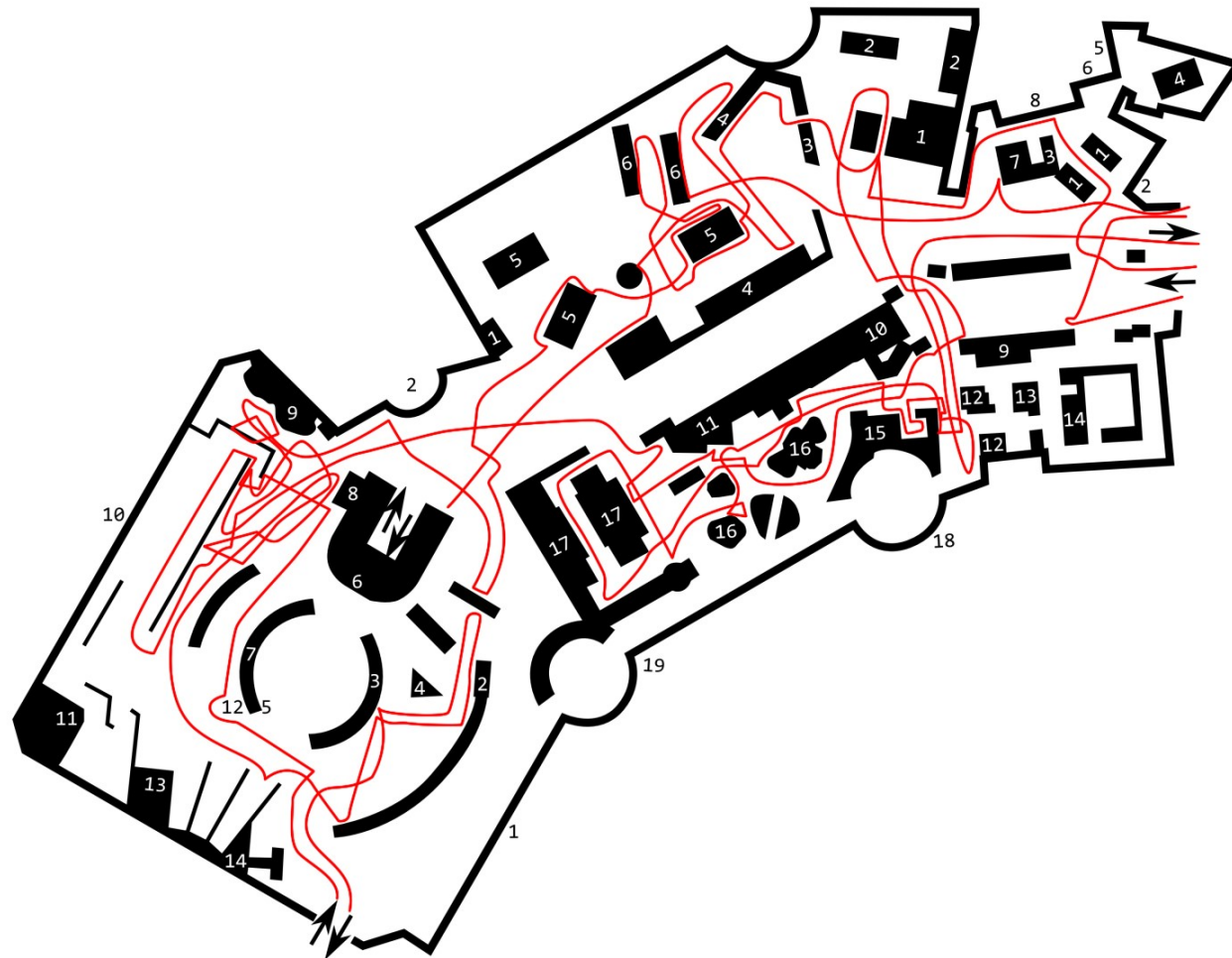


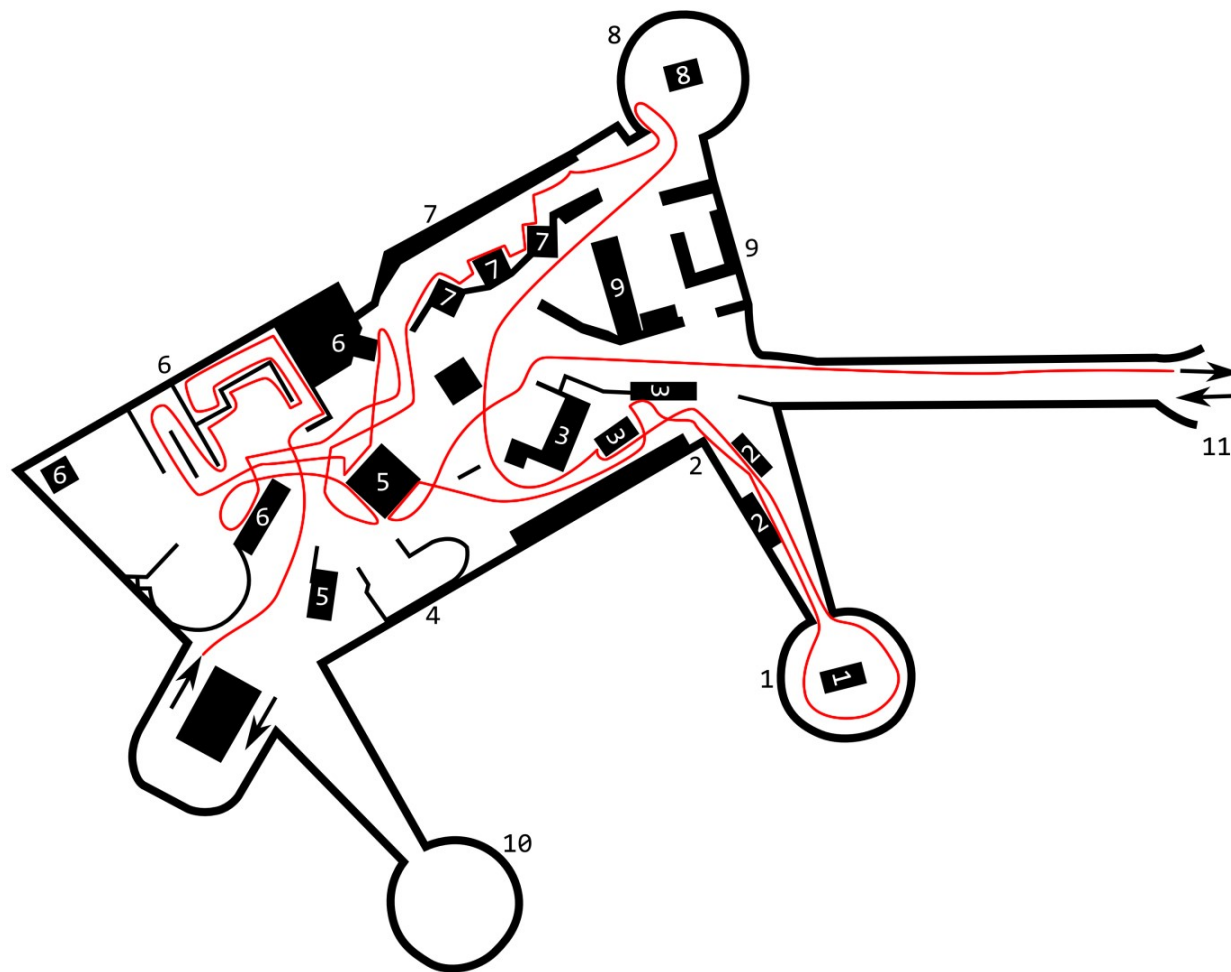
Track 9

Visitor Track Number:				9		
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/11/2015		Weekday:	Wednesday		
Des cription:	Two moms with 1 girl, 1 boy, and 1 toddler boy. Could be a family (cousins?) outing.					
Individual Demographics:	Gender:	Female	Attitude:	Curious		
	Age:	6				
Group Demographics:	# adults:	2	Leader:	Adults		
	#children:	3	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	11:05					
THA	11:11	11:48	0:37	5	0:06	Very into all exhibits
TEG	11:48	11:52	0:04	2	0:00	
NGC	11:53	12:19	0:26	13	0:01	Very energetic
BBQ	12:25	13:46	1:21		0:06	Social play, playing card game while young boy goes to sleep
THA	13:48	13:53	0:05	1	0:02	Crying because she got separated from mom
TEG	13:53	13:55	0:02	1	0:00	
THA	13:58	14:12	0:14	3	0:03	
SPW	14:13	14:27	0:14	9	0:01	
MPL	14:28	14:32	0:04		0:01	
SPW	14:32	14:43	0:11	6	0:00	
SCS	14:43	14:44	0:01	1	0:00	
TEG	14:46	14:54	0:08	4	0:02	
EXT		14:56			0:02	
Total Time		3:51		45		

Visitor Track Number:		9						T R P A O P S W																						
Code							P P T L L O A B E O D O R T H O A H																							
							U U U I E U R O A H I C D E E O C T E																							
							S L R F G C M D T I N O C A X T P C A																							
Exhib bit	Exhib it #	Time in	Time out	Durati on	Optimal Time	Transit Time	H	L	N	T	S	H	S	Y	E	T	T	N	O	D	T	O	L	H	R	Notes:				
THA	12	11:11	11:12	0:01	0:02												1	1							1	Explained by mom				
THA	11	11:13	11:24	0:11		0:01						2			3	3	2						1	1		Created 2 cars, talked with friend				
THA	16	11:24	11:27	0:03		0:00	2					3												1	1					
THA	17	11:27	11:38	0:11		0:00	2			2		1			2				2	1				2		Did rotating thing, created own alien				
THA	12	11:38	11:47	0:09	0:02	0:00								1	1									1		Waited to do cyborg thing				
TEG	4	11:49	11:50	0:01					2																1	Looked in a few doors, did one illusion				
TEG	5	11:51	11:52	0:01		0:01			1			1														Turned puzzle display				
NGC	6	11:53	11:57	0:04	0:05			1		1					1									1						
NGC	5	11:57	11:58	0:01		0:00	2									1			1				1			Lego City				
NGC	6	11:58	12:06	0:08	0:05	0:00	1					2				2	2							1		Excavator, figured out tools on tool wall				
NGC	5	12:06	12:06	0:00		0:00	4																			Lego city				
NGC	7	12:06	12:08	0:02	0:04	0:00	2											1						3		Watched videos				
NGC	8	12:08	12:10	0:02		0:00																				No interactions, just looked in mirrors				
NGC	5	12:10	12:10	0:00		0:00			1																	Played with clock				
NGC	3	12:10	12:11	0:01		0:00	2																			Pushed microscope slides				
NGC	2	12:11	12:12	0:01	0:05	0:00			2			1												1		Microscope				
NGC	1	12:12	12:13	0:01		0:00									1									1						
NGC	2	12:13	12:15	0:02	0:05	0:00				1									1							Microscope				
NGC	3	12:15	12:15	0:00		0:00	1					1																		
NGC	5	12:17	12:19	0:02		0:02	11										1									Lego city				
THA	8	13:48	13:53	0:05					1			3			1									1	1	City simulator				
TEG	1	13:53	13:55	0:02											1											Crawled through tunnel				

THA	11	13:58	14:10	0:12							1			3	3	2			1	1	Did car thing multiple times
THA	17	14:10	14:10	0:00		0:00				2											Lifted 2 cans (gravity display)
THA	11	14:10	14:12	0:02		0:00					1		1								
SPW	10	14:13	14:15	0:02															1		
SPW	9	14:15	14:15	0:00		0:00							1								Climbed on wall
SPW	10	14:15	14:17	0:02		0:00			4										1		Watched race, didn't do it
SPW	8	14:17	14:19	0:02		0:00													1		Waited in line to do snowboard, didn't do it
SPW	5	14:19	14:20	0:01		0:00													1		
SPW	13	14:20	14:21	0:01		0:00						1							1		Threw ball once
SPW	2	14:22	14:23	0:01		0:01				1									1		
SPW	3	14:24	14:24	0:00		0:01						1							1		
SPW	2	14:25	14:27	0:02		0:01					2	1									
MPL	1	14:28	14:32	0:04					1		2								1		
SPW	12	14:32	14:35	0:03								1					1		1		Did wheelchair race with help from mom
SPW	8	14:36	14:38	0:02		0:01	2			1							1		1		Tried snowboard
SPW	10	14:38	14:41	0:03	0:01	0:00	4						1						1	1	Only did race once
SPW	9	14:41	14:42	0:01		0:00							1								
SPW	10	14:42	14:43	0:01	0:01	0:00	1												1		
SPW	8	14:43	14:43	0:00		0:00				1									1		
SCS	1	14:43	14:44	0:01							1								1		
TEG	5	14:46	14:47	0:01					1			1							1		
TEG	6	14:47	14:51	0:04		0:00	5	3	6	2					1						Pushed dishes through right holes
TEG	5	14:51	14:52	0:01		0:00			1										1		
TEG	6	14:52	14:54	0:02		0:00			2	4						1					

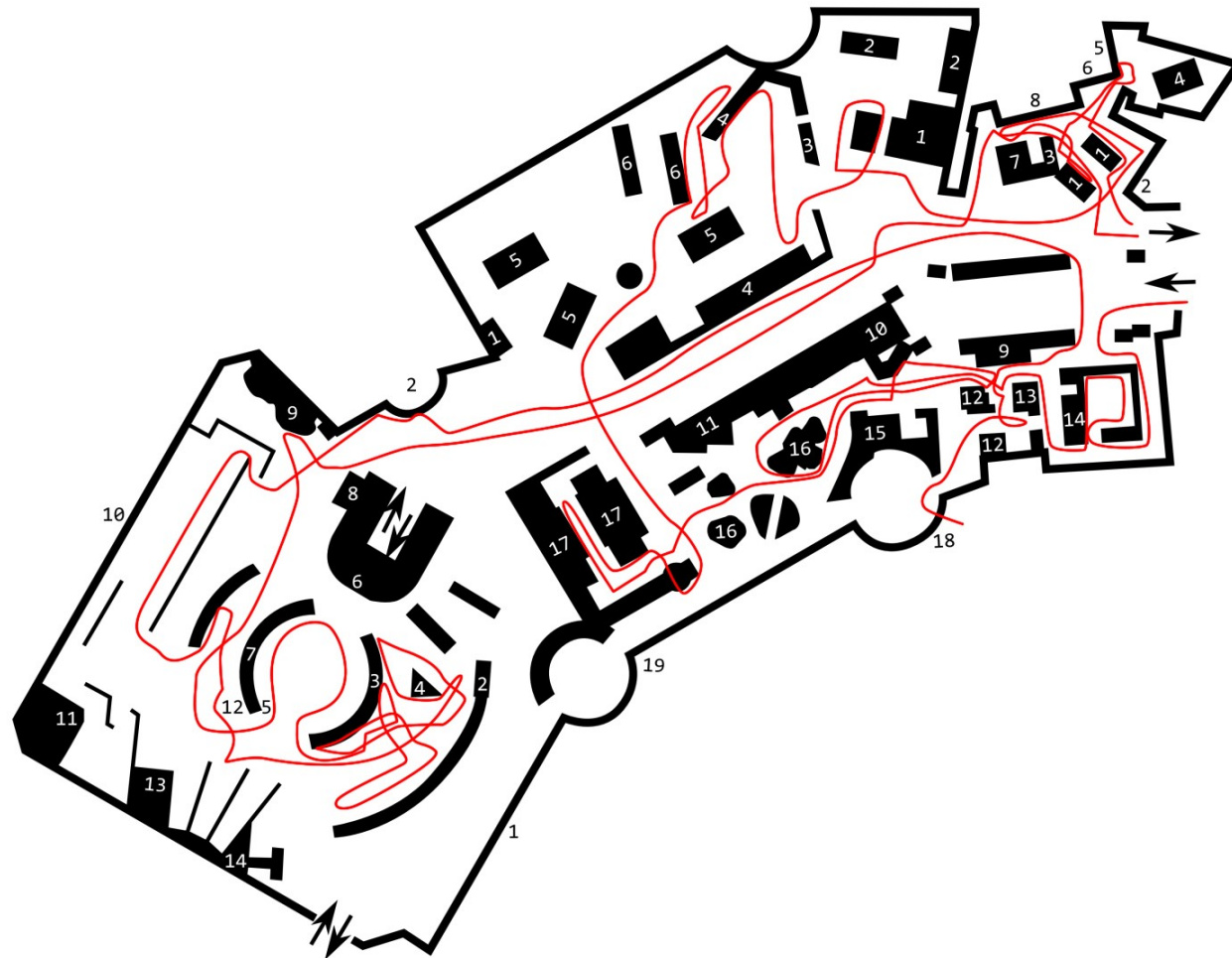


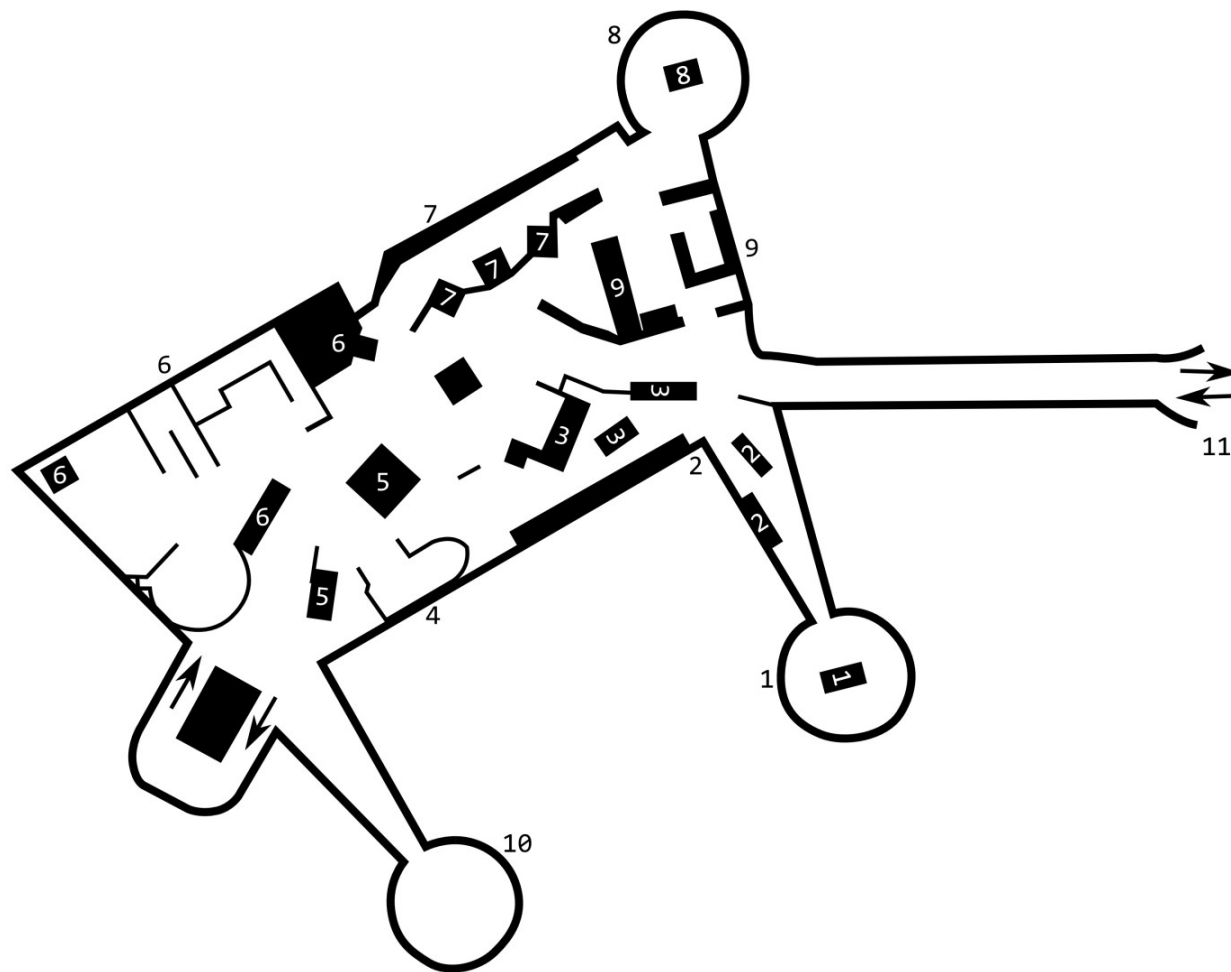


Track 10

Visitor Track Number:			10			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/12/15		Weekday:	Thursday		
Description:	Child with baby sibling, mother, father, grandpa					
Individual	Gender:	Male	Attitude:	Excited		
Demographics:	Age:	8				
Group	# adults:	3	Leader:	Child		
Demographics:	#children:	2	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	11:22					Bathroom trip before going into exhibits
THA	11:29	11:40	0:11	7	0:07	
TEG	11:40	11:44	0:04	4	0:00	Too excited to stay at one exhibit for long
THA	11:45	11:49	0:04	3	0:01	
PLA	11:50	11:57	0:07		0:01	
THA	11:57	12:06	0:09	1	0:00	
SCS	12:07	12:07	0:00	1	0:01	
SPW	12:08	12:23	0:15	12	0:01	Short attention span, doesn't seem to like other kids
THA	12:23	12:28	0:05	3	0:00	
SHP	12:28	12:33	0:05		0:00	
CAF	12:35	12:36	0:01		0:02	
EXT		12:38			0:02	
Total Time		1:16		31		

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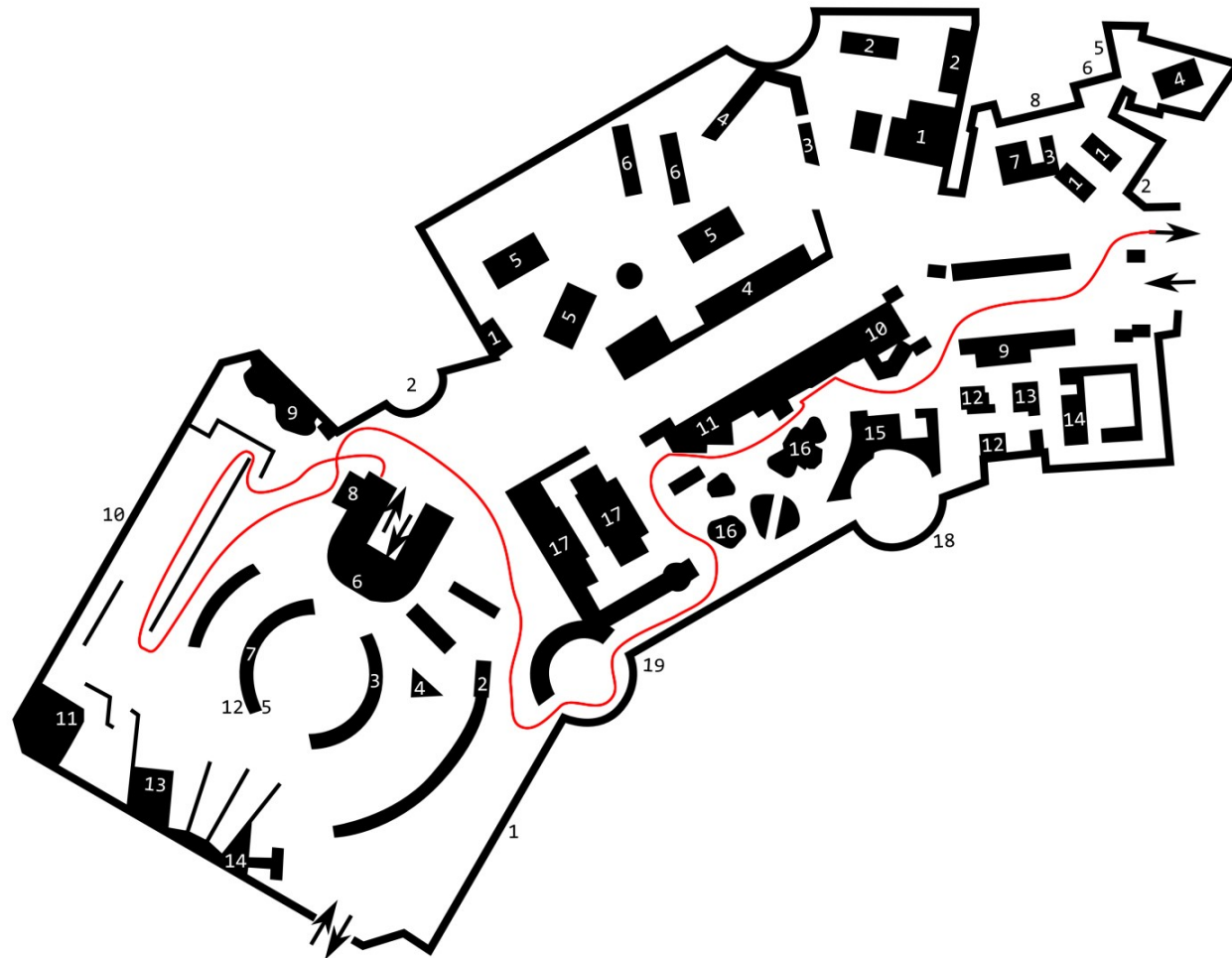


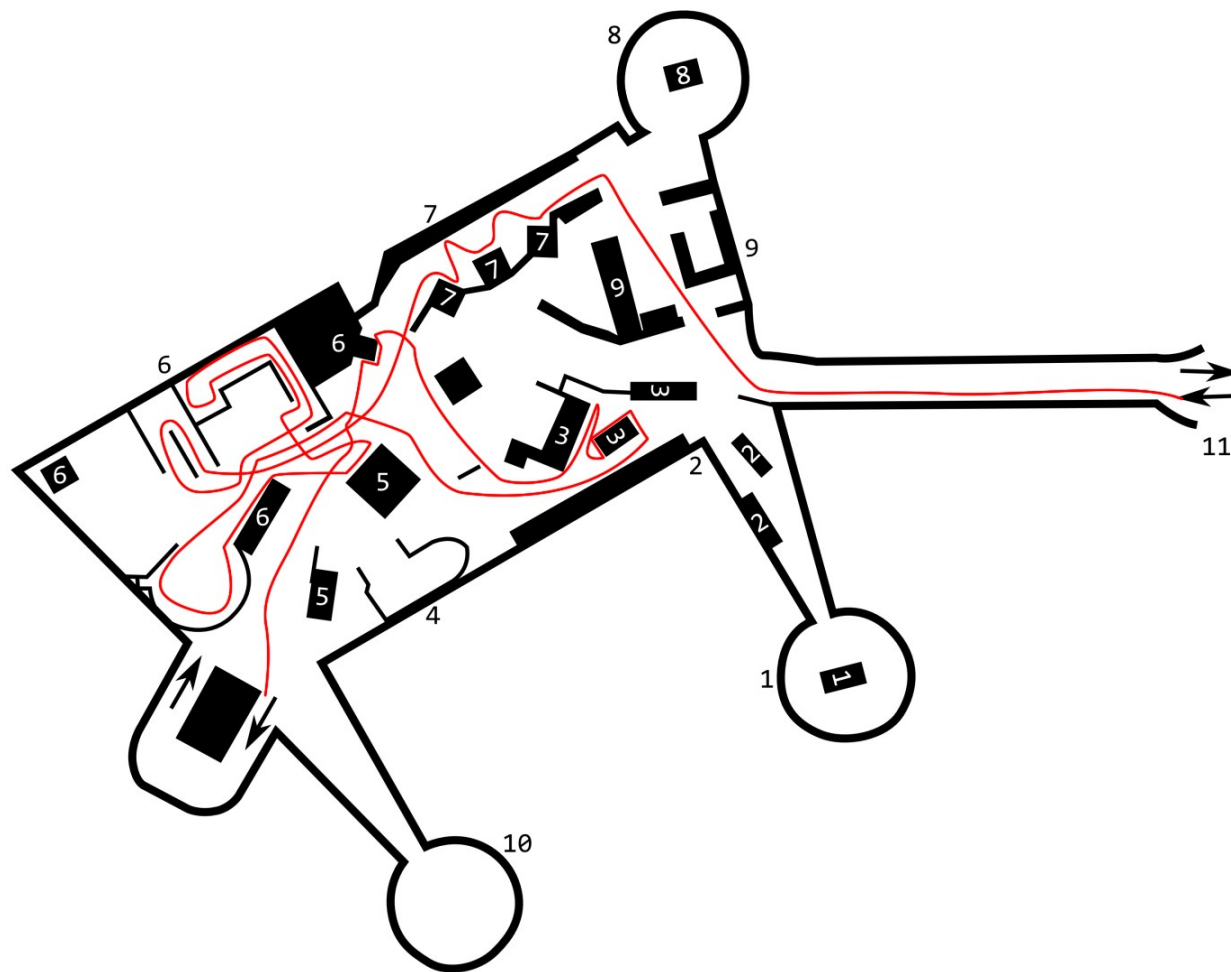


Track 11

Visitor Track Number:			11			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/13/2015		Weekday:	Friday		
Des cription:	Young boy and his mom					
Individual Demographics:	Gender:	Male	Attitude:	Excited		
	Age:	5				
Group Demographics:	# adults:	1	Leader:	Adult		
	#children:	1	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:01					
PLA	10:06	10:20	0:14		0:05	
BBQ	10:21	10:26	0:05		0:01	Had to be called away to go inside
NGC	10:28	11:01	0:33	6	0:02	
SPW	11:02	11:07	0:05	2	0:01	
THA	11:08	11:20	0:12	2	0:01	Mom picked him up to leave
EXT		11:21			0:01	
Total Time		1:20		10		

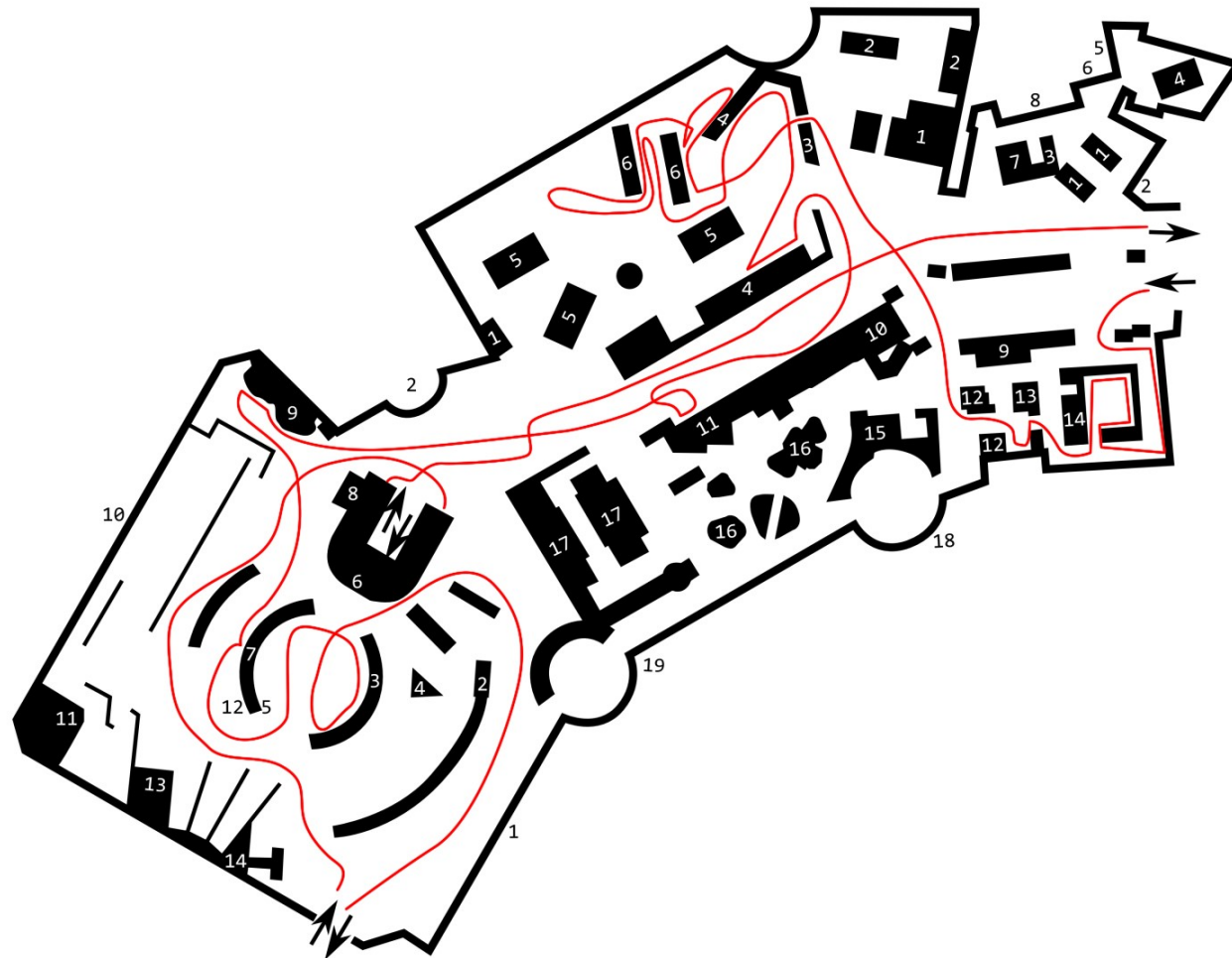
Visitor Track Number:							11																			
Code							P	P	T	L	L	O	A	B	E	O	D	O	R	T	H	O	A	H		
							U	U	I	E	U	R	O	A	H	I	C	D	E	E	O	C	T	E		
							S	L	R	F	G	C	M	D	T	I	N	O	C	A	X	T	P	C	A	
							H	L	N	T	S	H	S	Y	E	T	T	N	O	D	T	O	L	H	R	Notes:
NGC	7	10:29	10:32	0:03	0:04		2	2								1	1						3		Mom very involved in helping him	
NGC	6	10:32	10:42	0:10	0:05	0:00	2	2	2						1		1					1			Finished whole wall	
NGC	5	10:42	10:43	0:01		0:00	3									1	1									
NGC	6	10:43	10:53	0:10	0:05	0:00		1						2			1									
NGC	3	10:53	10:57	0:04		0:00	7									1	2								Very intrigued by microscope sliders	
NGC	6	10:58	11:01	0:03	0:05	0:01							1				1						1			
SPW	10	11:02	11:05	0:03	0:01		3							6									1		Ran race 6 times	
SPW	8	11:05	11:07	0:02		0:00				1													1		Did snowboard with mom	
THA	11	11:08	11:15	0:07								1		2			1						2			
THA	10	11:16	11:20	0:04		0:01						2			2		1								Eating snack while looking at exhibit	

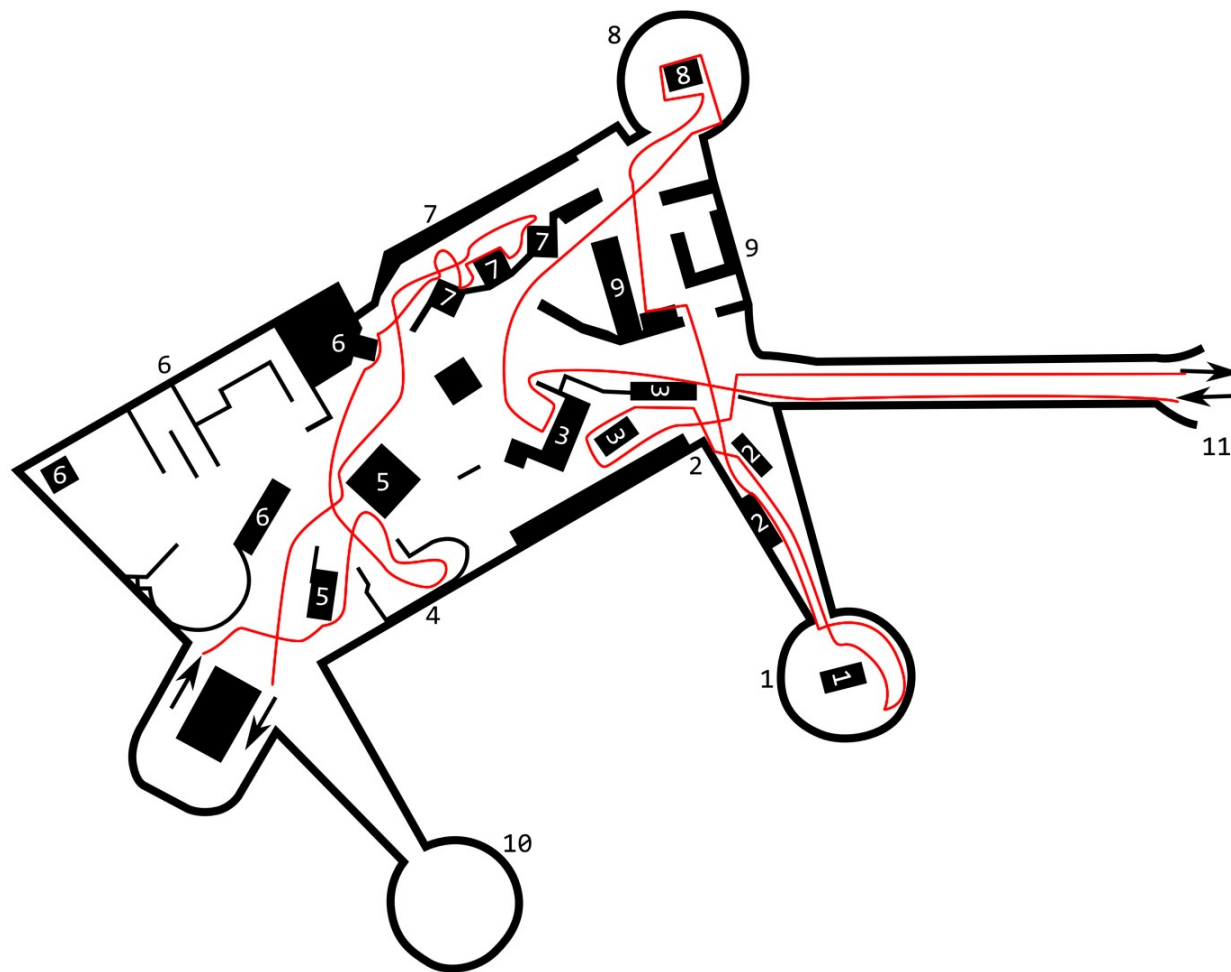




Track 12

Visitor Track Number:			12			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/13/2015		Weekday:	Friday		
Des cription:	Young boy, younger sister, mom and dad					
Individual Demographics:	Gender:	Male	Attitude:	Cautious		
	Age:	6				
Group Demographics:	# adults:	2	Leader:	Adult		
	#children:	2	School?:			
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	11:56					
THA	11:58	12:01	0:03	2	0:02	
TEG	12:02	12:08	0:06	2	0:01	
THA	12:08	12:09	0:01	2	0:00	Lots of of older kids around, seems to be making parents nervous
SPW	12:10	12:15	0:05	2	0:01	
MPL	12:19	12:24	0:05	1	0:04	Always holding dad's hand
SPW	12:25	12:27	0:02	1	0:01	
NGC	12:29	12:37	0:08	4	0:02	
CAF	12:43	12:57	0:14		0:06	
BBQ	12:58	13:01	0:03		0:01	
NGC	13:04	13:16	0:12	6	0:03	Seem to be reprimanded by each parent at separate times
SHP	13:18	13:30	0:12		0:02	
EXT		13:31			0:01	
Total Time		1:35		20		

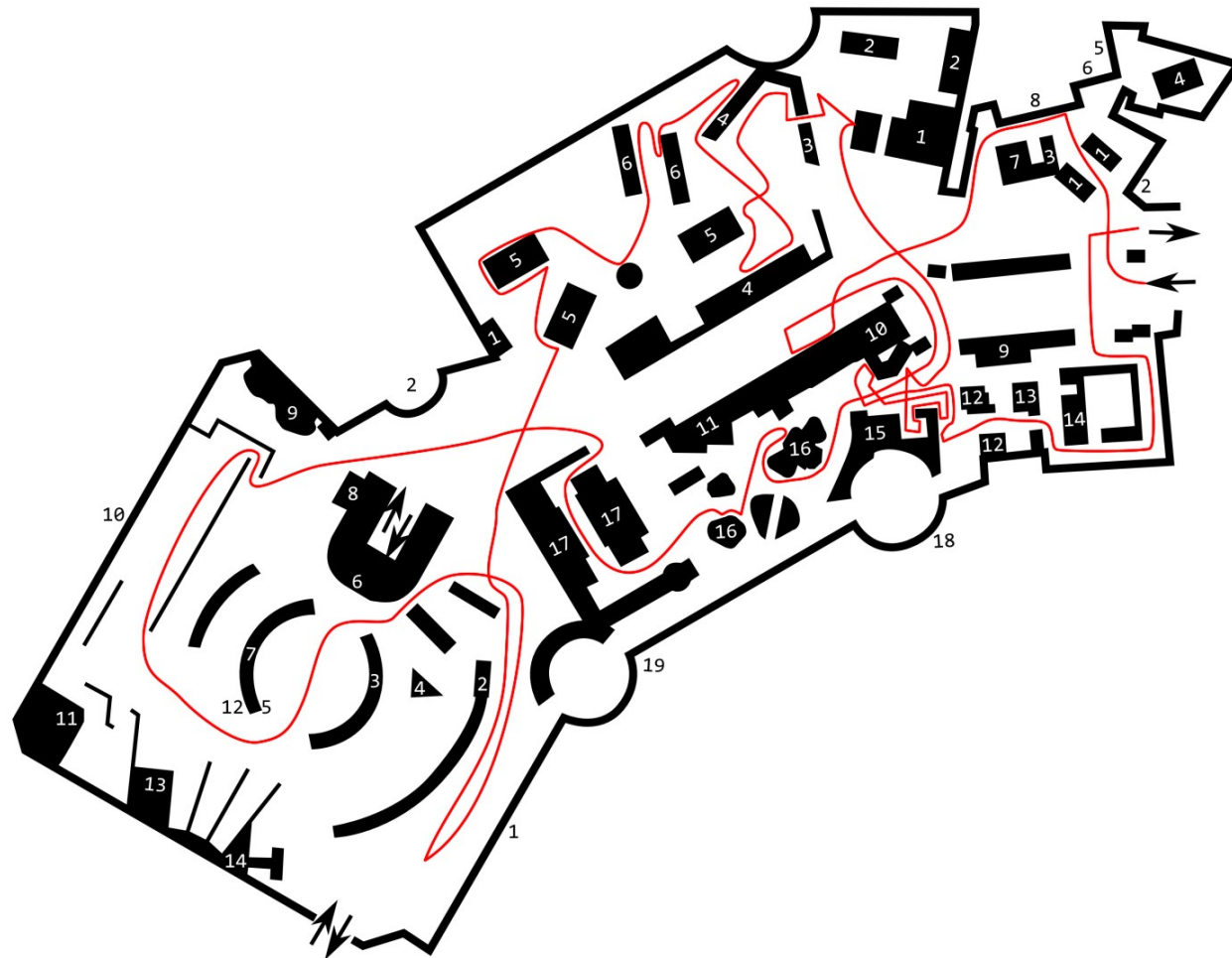


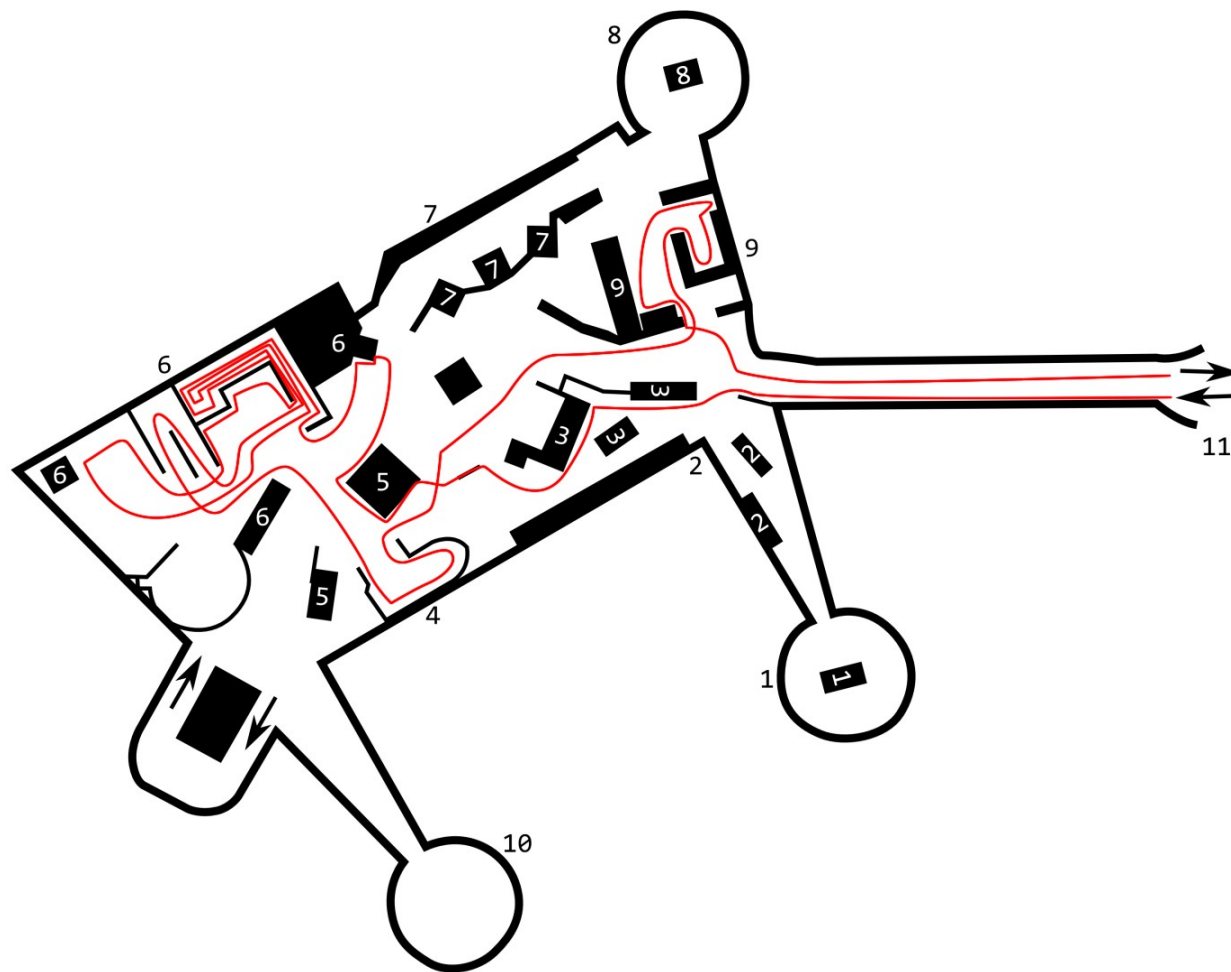


Track 13

Visitor Track Number				13		
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/16/2015		Weekday:	Monday		
Description:	Mother and son					
Individual Demographics:	Gender:	Male	Attitude:	Excited		
	Age:	5				
Group Demographics:	# adults:	1	Leader:	Adult		
	#children:	1	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:27					Very interactive whole time
NGC	10:31	11:24	0:53	5	0:04	
THA	11:25	11:36	0:11	4	0:01	
SPW	11:36	11:39	0:03	1	0:00	
TEG	11:41	11:52	0:11	4	0:02	
THA	11:53	11:58	0:05	3	0:01	Doesn't play well with others
BBQ	12:04	12:17	0:13		0:06	
CAF	12:18	12:48	0:30		0:01	
EXT		12:50			0:02	
Total Time		2:23		17		

Visitor Track Number:		13													T R P A O P S W														
Code															P P T L L O A B E O D O R T H O A H														
															U U U I E U R O A H I C D E E O C T E														
															S L R F G C M D T I N O C A X T P C A														
															H L N T S H S Y E T T N O D T O L H R														
Exhi bit	Exhib it #	Time in	Time out	Durati on	Optimal Time	Transit Time																			Notes:				
NGC	3	10:31	10:35	0:04			6						1	1		1	2								1	Mom very involved right away			
NGC	5	10:35	10:38	0:03		0:00	17									9	1									Lego city			
NGC	6	10:38	11:04	0:26	0:05	0:00	4	2	4	3			1	1			1						3			Excavator, played with others at wall			
NGC	4	11:04	11:07	0:03		0:00		1	1		2																		
NGC	9	11:07	11:23	0:16		0:00			2	3					1		2						1			When playing with fake food actually looks like lots of thought going into it			
THA	8	11:26	11:27	0:01									1		1			1									Not interested in city thing		
THA	10	11:27	11:29	0:02		0:00										1	1												
THA	16	11:29	11:35	0:06		0:00	6						1				3	2						1		Did pressure rocket many times			
THA	17	11:35	11:36	0:01		0:00										1													
SPW	10	11:36	11:39	0:03	0:01		2								6												Ran race 6 times		
TEG	5	11:41	11:45	0:04					2				1					1											
TEG	6	11:45	11:47	0:02		0:00	2		1	2							1									Mom leads him through Alice exhibition			
TEG	4	11:47	11:48	0:01		0:00	1		2								1							2					
TEG	3	11:48	11:52	0:04		0:00			4								1												
THA	10	11:53	11:54	0:01							1																		
THA	12	11:54	11:56	0:02	0:02	0:00								1	1		1	1						1		Did cyborg thing			
THA	10	11:56	11:58	0:02		0:00					1						1	1											



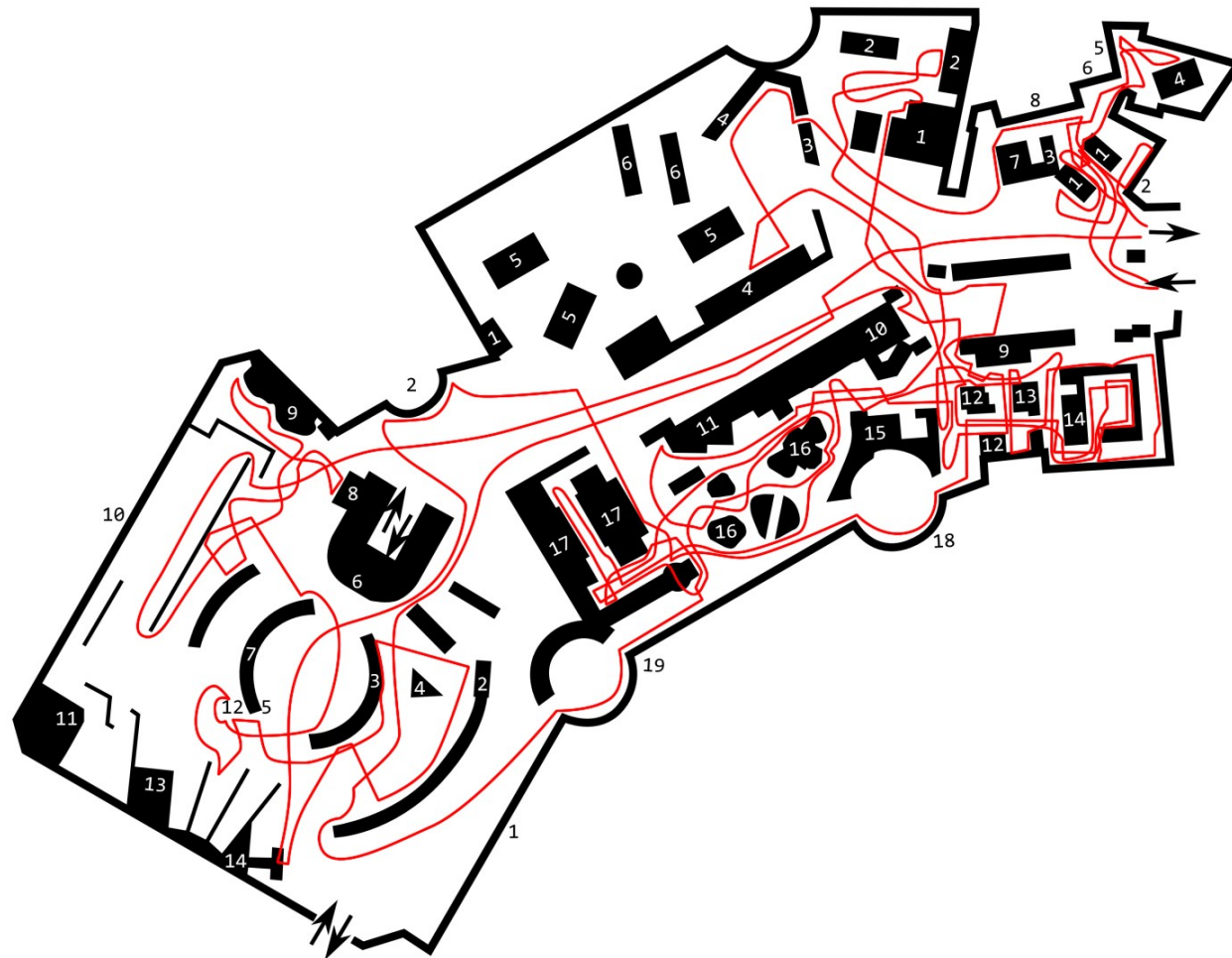


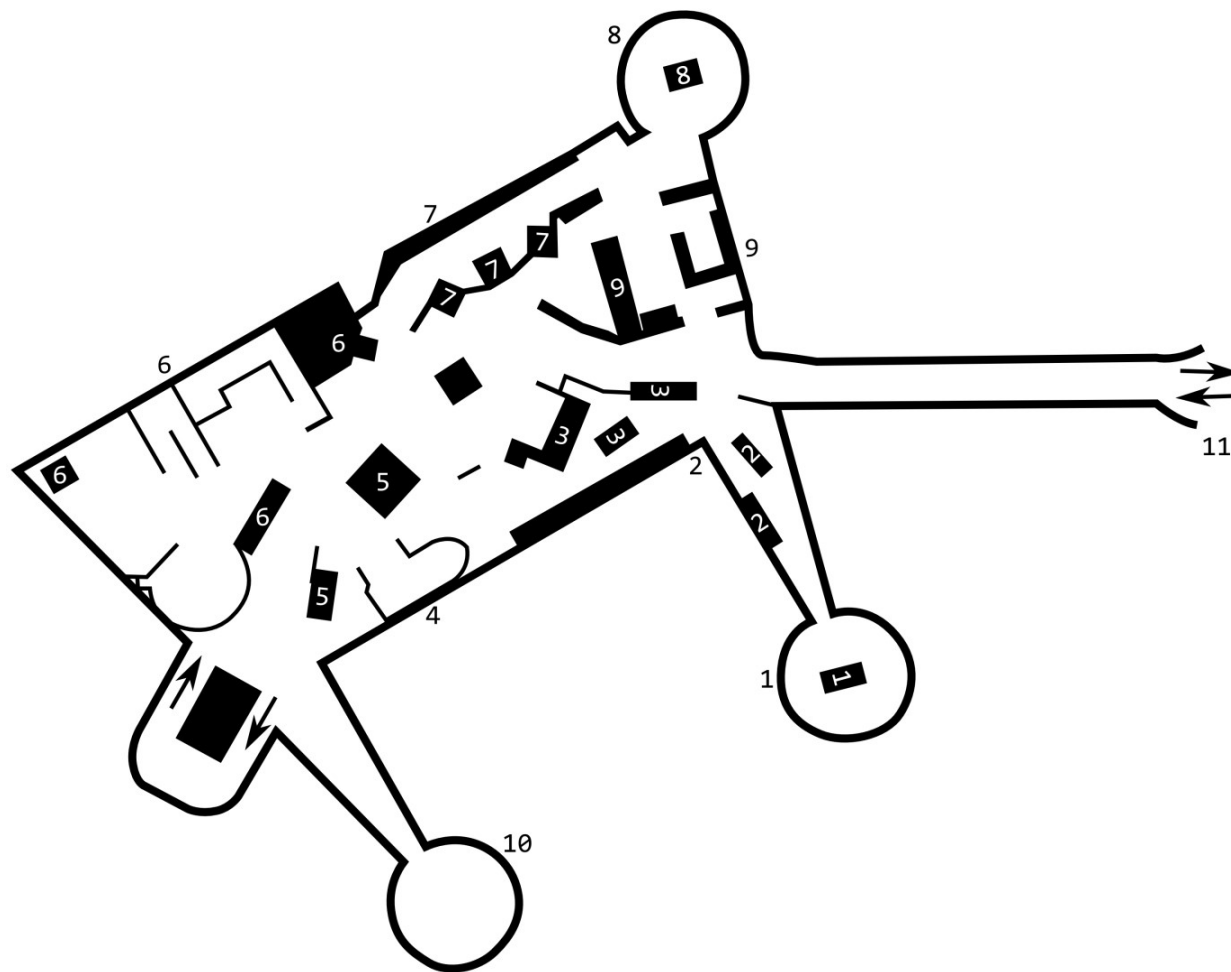
Track 14

Visitor Track Number:				14		
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/17/2015		Weekday:	Tuesday		
Description:	Father, mother, 2 boys and 1 girl. Girl looks to be oldest sibling					
Individual Demographics:	Gender:	Female	Attitude:	Passive		
	Age:	12				
Group Demographics:	# adults:	2	Leader:	Child		
	#children:	3	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:04					
THA	10:07	10:18	0:11	4	0:03	Very independent of parents
TEG	10:19	10:20	0:01	1	0:01	
THA	10:21	10:31	0:10	6	0:01	
TEG	10:32	10:34	0:02	3	0:01	
THA	10:35	10:58	0:23	5	0:01	
SPW	11:01	11:37	0:36	14	0:03	Very involved in discovering exhibits with parents in this section
SCS	11:38	11:40	0:02	1	0:01	
THA	11:40	11:55	0:15	7	0:00	
SPW	11:56	11:57	0:01	1	0:01	
THA	12:03	12:17	0:14	7	0:06	
LGR	12:20	12:58	0:38		0:03	
BBQ	12:58	13:10	0:12		0:00	
PST	13:10	13:11	0:01		0:00	
BBQ	13:11	13:19	0:08		0:00	
EXT		13:21			0:02	
Total Time		3:17		49		

[illegible]

SPW	10	11:09	11:12	0:03	0:01	0:02												1			1	1		
SPW	7	11:13	11:13	0:00		0:01				1												1		
SPW	5	11:14	11:15	0:01		0:01	1															1		Watched swimming video
SPW	12	11:15	11:15	0:00		0:00																1		Watched others do race
SPW	7	11:16	11:16	0:00		0:01												1						
SPW	12	11:16	11:21	0:05		0:00																1		
SPW	13	11:21	11:22	0:01		0:00					2													Netball, baseball
SPW	12	11:22	11:24	0:02		0:00					1											1		Finally got to do race with mom
SPW	3	11:25	11:28	0:03		0:01	3	1				1						1				1		
SPW	2	11:28	11:36	0:08		0:00					1	1	1	1				2	4			1		
SPW	14	11:36	11:37	0:01		0:00	1															1		
SCS	1	11:38	11:40	0:02							1							1	2					
THA	17	11:40	11:42	0:02			2		6															
THA	14	11:43	11:45	0:02		0:01	1											1				2		
THA	12	11:45	11:47	0:02	0:02	0:00							1	1										Actually did cyborg thing now
THA	15	11:47	11:47	0:00		0:00						1												
THA	10	11:47	11:48	0:01		0:00						1						1	1					
THA	16	11:48	11:49	0:01		0:00						1						2						
THA	17	11:49	11:55	0:06		0:00						1		1								1		Did create your own alien
SPW	2	11:56	11:57	0:01						2														
THA	1	12:03	12:03	0:00								1										1		
THA	8	12:03	12:05	0:02		0:00						1		1										
THA	6	12:06	12:08	0:02		0:01						1		1										Shoe creator
THA	4	12:08	12:09	0:01		0:00												1				1		
THA	5	12:09	12:11	0:02		0:00						1												
THA	1	12:11	12:15	0:04		0:00						1										1	1	
THA	2	12:15	12:17	0:02		0:00		1	1										1					

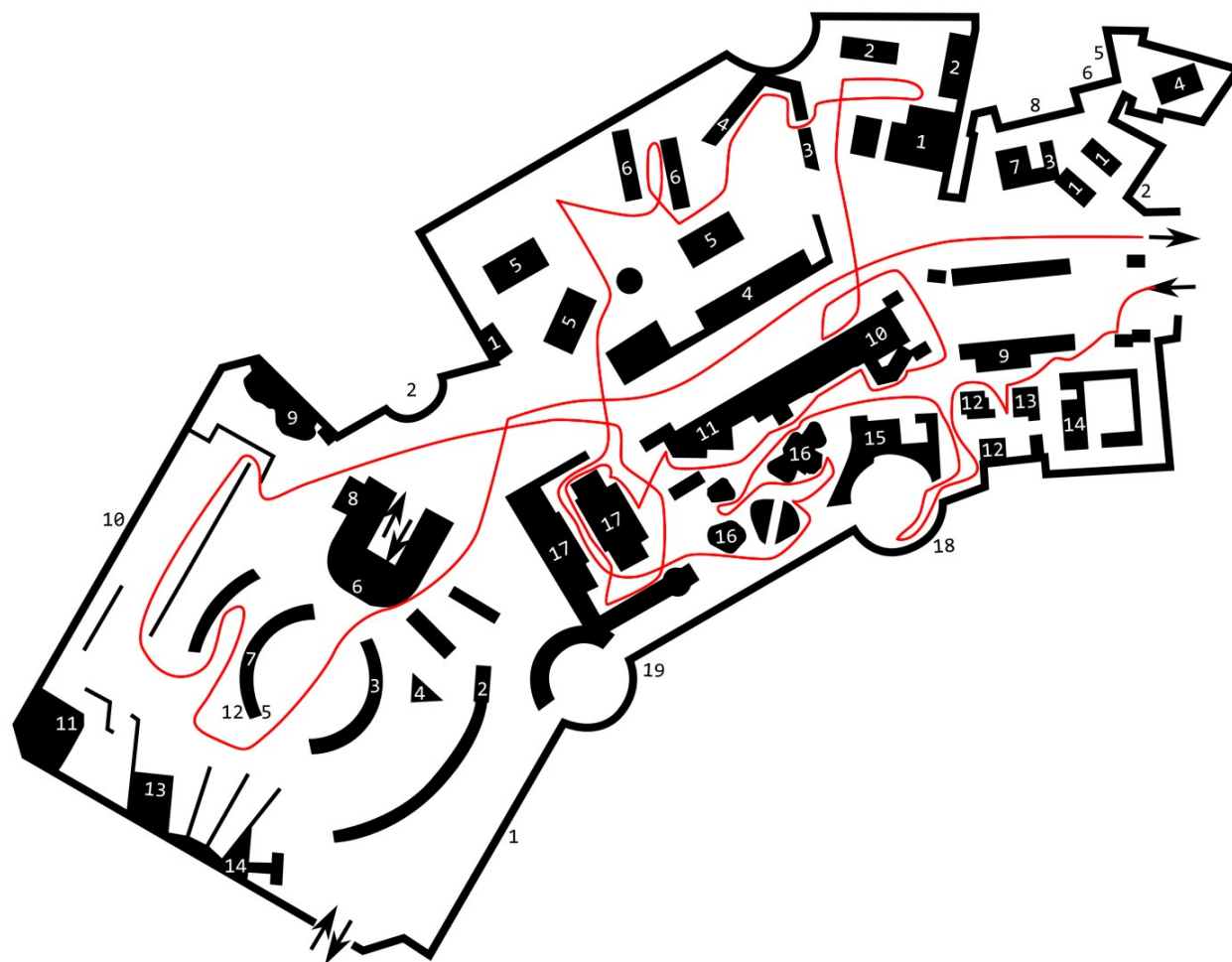


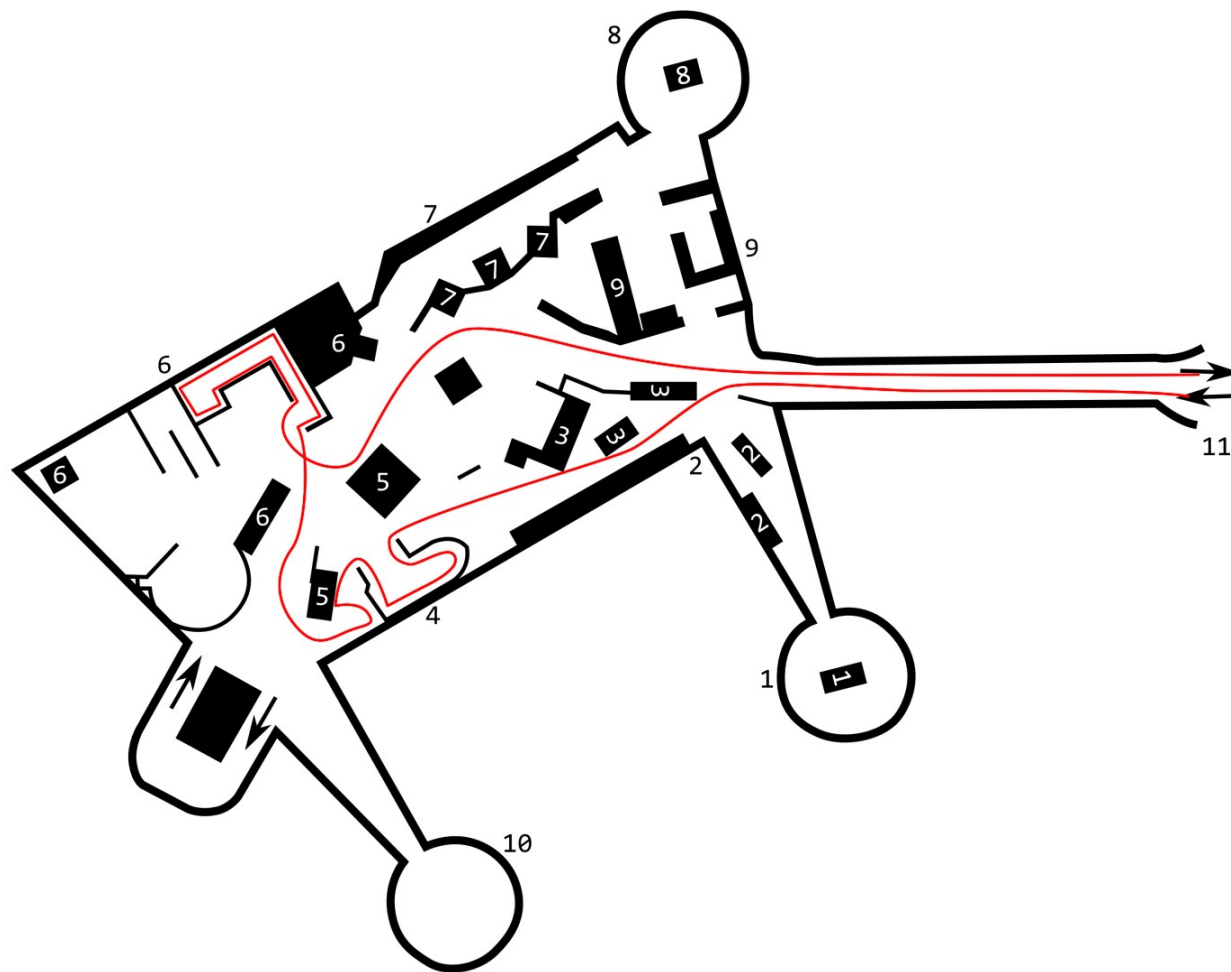


Track 15

Visitor Track Number:			15			
Investigator:	Zach/Michelle		Location:	Scienceworks		
Date:	11/17/2015		Weekday:	Tuesday		
Description:	A boy and his mother, boy walked in shirtless for some reason					
Individual Demographics:	Gender:	Male	Attitude:	Calm		
	Age:	5				
Group Demographics:	# adults:	1	Leader:	Adult		
	#children:	1	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	14:23					Moves really fast from exhibit to exhibit
SHP	14:24	14:29	0:05		0:01	
THA	14:29	14:39	0:10	4	0:00	
TEG	14:39	14:44	0:05	4	0:00	
THA	14:44	15:00	0:16	4	0:00	
SPW	15:01	15:03	0:02	2	0:01	Left mom's side for a minute, so he got in trouble and they left
NGC	15:16	15:21	0:05	3	0:13	
EXT		15:25			0:04	
Track Time		1:02		17		

[illegible]

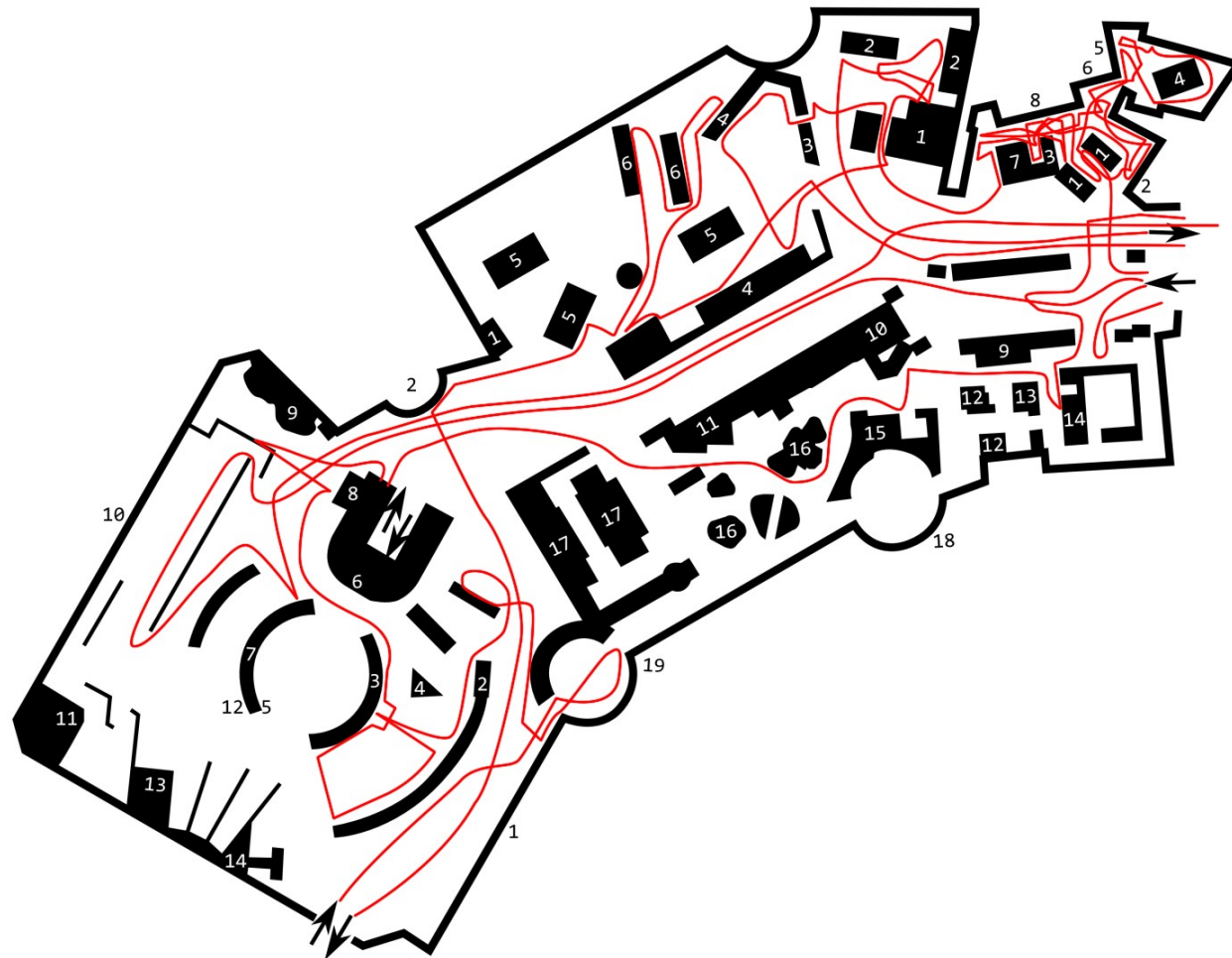


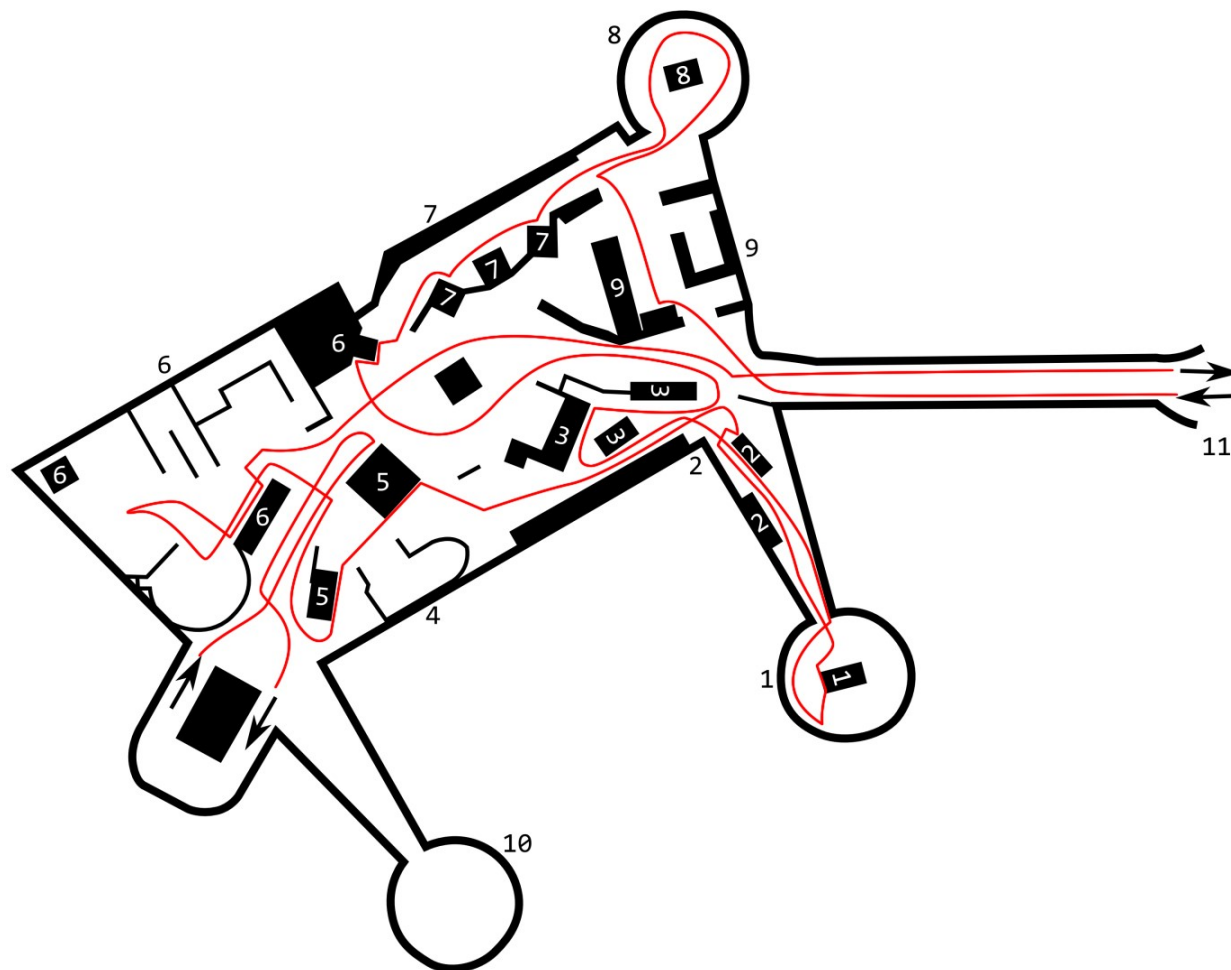


Track 16

Visitor Track Number:			16			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/18/2015		Weekday:	Wednesday		
Des cription:	Mom with two daughters, looks like it was their first time					
Individual	Gender:	Female	Attitude:	Calm		
Demographics:	Age:	11				
Group	# adults:	1	Leader:	Child		
Demographics:	#children:	2	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:54					
SEG (Vis Illusions)	10:56	11:16	0:20	1	0:02	
THA	11:17	11:45	0:28	12	0:01	Yo-yoed away from mom and sister. Tries to move faster and makes stops on the row but gets pulled back to slower moving mom
TEG	11:45	11:57	0:12	7	0:00	
Collections Tour	12:00	12:38	0:38		0:03	
TEG	12:39	12:48	0:09	4	0:01	
MPL	12:50	12:57	0:07	1	0:02	Bathroom break in Planetarium
THA	12:57	12:59	0:02	1	0:00	
SPW	13:00	13:13	0:13	6	0:01	
NGC	13:14	13:15	0:01	1	0:01	
THA	13:15	13:21	0:06	4	0:00	
NGC	13:23	13:42	0:19	9	0:02	
PLA	13:47	14:14	0:27		0:05	
SPW	14:16	14:19	0:03	2	0:02	
SHP	14:20	14:26	0:06		0:01	
EXT		14:27			0:01	
Total Time		3:33		48		

[illegible]



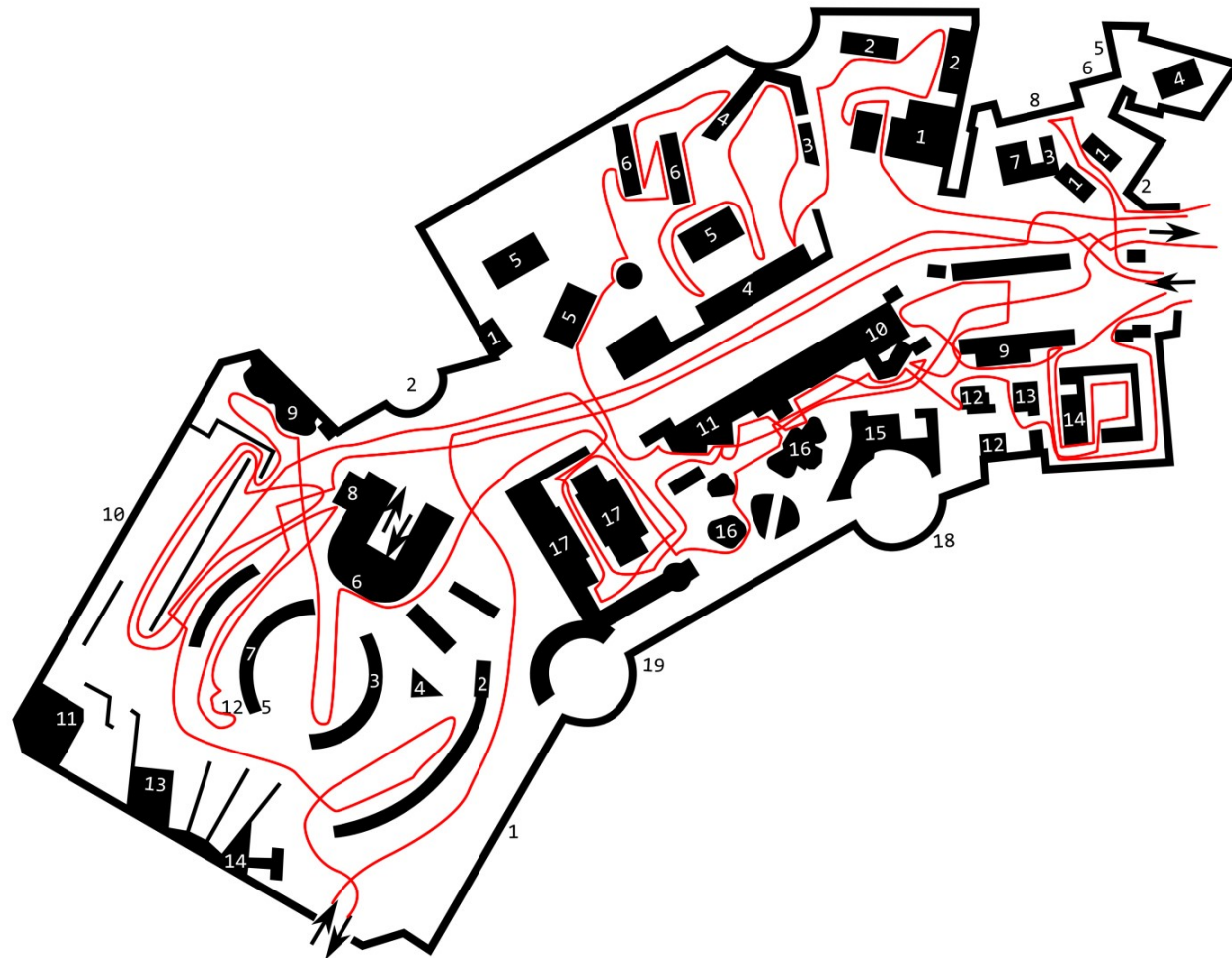


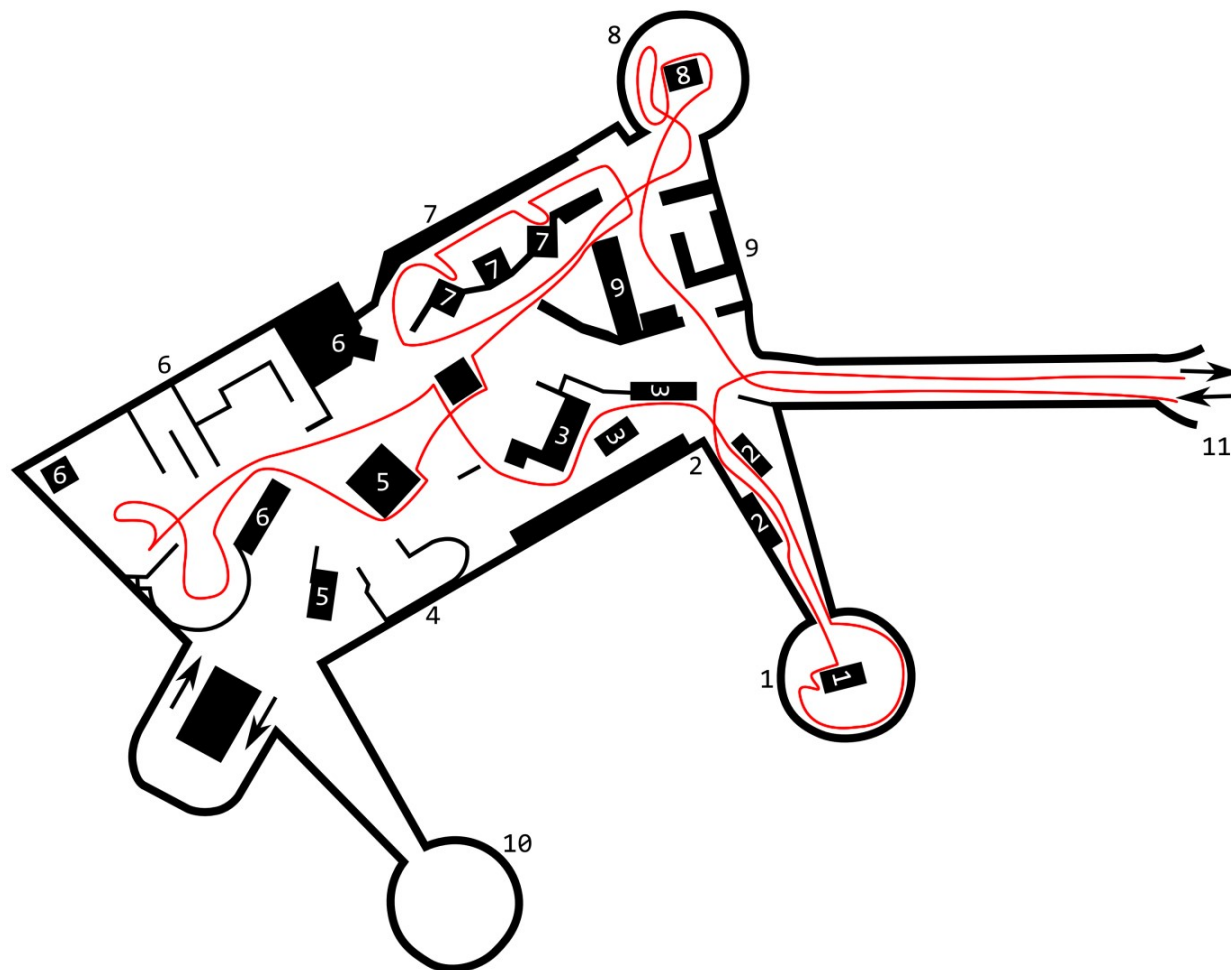
Track 17

Visitor Track Number:			17			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/19/2015		Weekday:	Thursday		
Des cription:	Young boy with older sister and grandma					
Individual	Gender:	Male	Attitude:	Calm		
Demographics:	Age:	7				
Group	# adults:	1	Leader:	Adult		
Demographics:	#children:	2	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:01					
TEG	10:04	10:31	0:27	7	0:03	Grandma very involved in explanations
THA	10:31	10:45	0:14	1	0:00	
CAF	10:50	11:02	0:12		0:05	
THA	11:03	11:40	0:37	7	0:01	
SPW	11:42	11:57	0:15	5	0:02	
CAF	12:01	12:21	0:20		0:04	
LGR	12:21	12:58	0:37		0:00	
NGC	13:07	13:36	0:29	9	0:09	
THA	13:38	13:40	0:02	2	0:02	Bathroom break
THA	13:43	14:13	0:30	8	0:03	
SCS	14:13	14:14	0:01	1	0:00	
SPW	14:16	14:18	0:02	2	0:02	
MPL	14:19	15:15	0:56		0:01	
EXT		15:15			0:00	
Total Time		5:14		42		

[illegible]

[illegible]

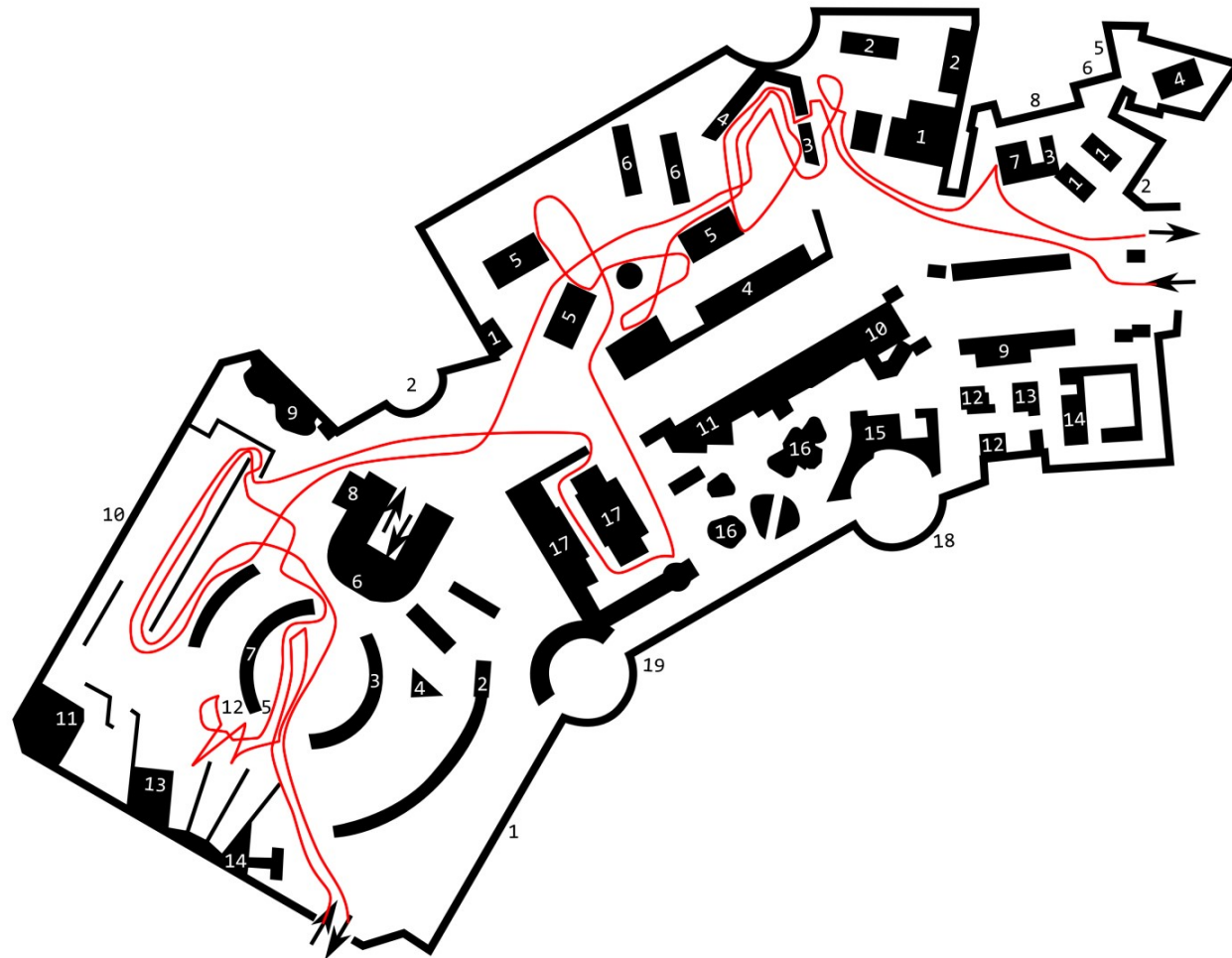


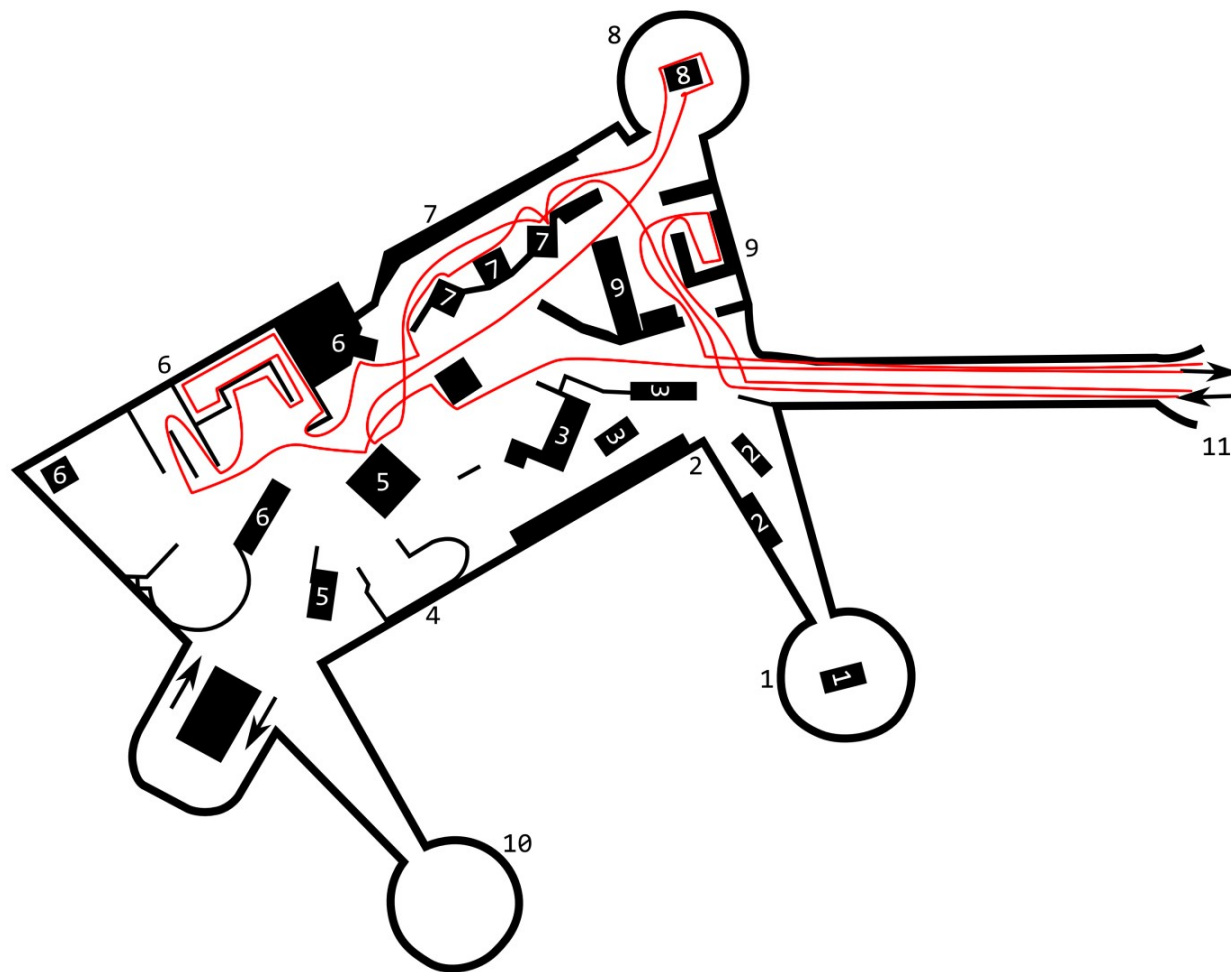


Track 18

Visitor Track Number:			18			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/20/2015		Weekday:	Friday		
Description:	Young girl with younger sister, her friend, friend's younger brother and her mom. They are watching the the friend and her friends sibling because their mom is a chaperone on a field trip here.					
Individual Demographics:	Gender:	Female	Attitude:	Calm		
	Age:	5				
Group Demographics:	# adults:	1	Leader:	Adult		
	#children:	4	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:06					
PLA	10:11	10:53	0:42		0:05	
NGC	10:55	11:25	0:30	5	0:02	Bathroom break
NGC	11:30	11:44	0:14	1	0:05	
AMP	11:48	12:27	0:39		0:04	
PLA	12:28	12:36	0:08		0:01	
TEG	12:40	13:04	0:24	4	0:04	
THA	13:06	13:11	0:05	1	0:02	
SW	13:11	13:21	0:10	2	0:00	
MPL	13:22	13:28	0:06	1	0:01	Bathroom
SPW	13:29	13:53	0:24	5	0:01	
TEG	13:54	13:57	0:03	1	0:01	
THA	13:57	13:58	0:01	1	0:00	
EXT		14:04			0:06	
Total Time		3:58		21		

[illegible]



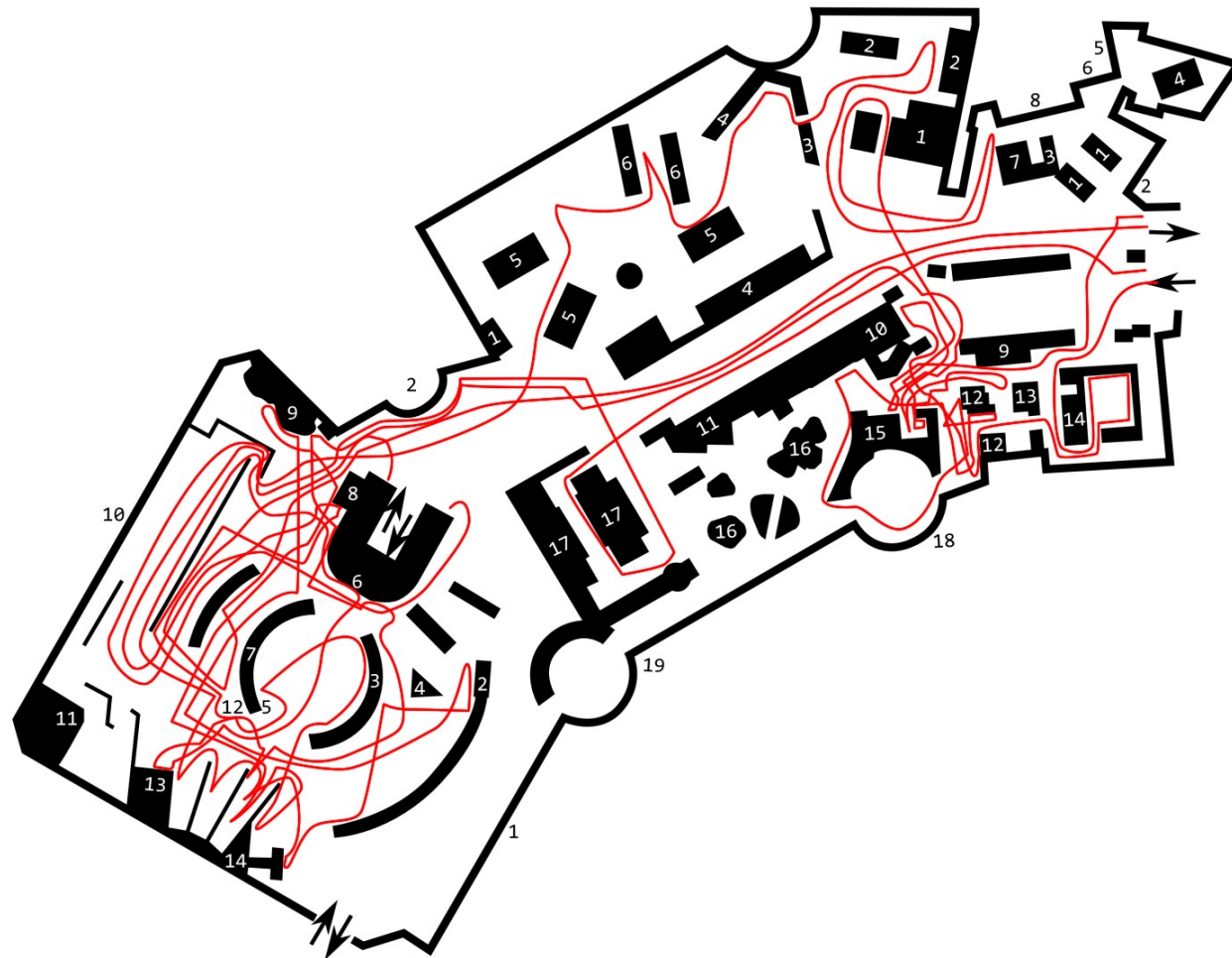


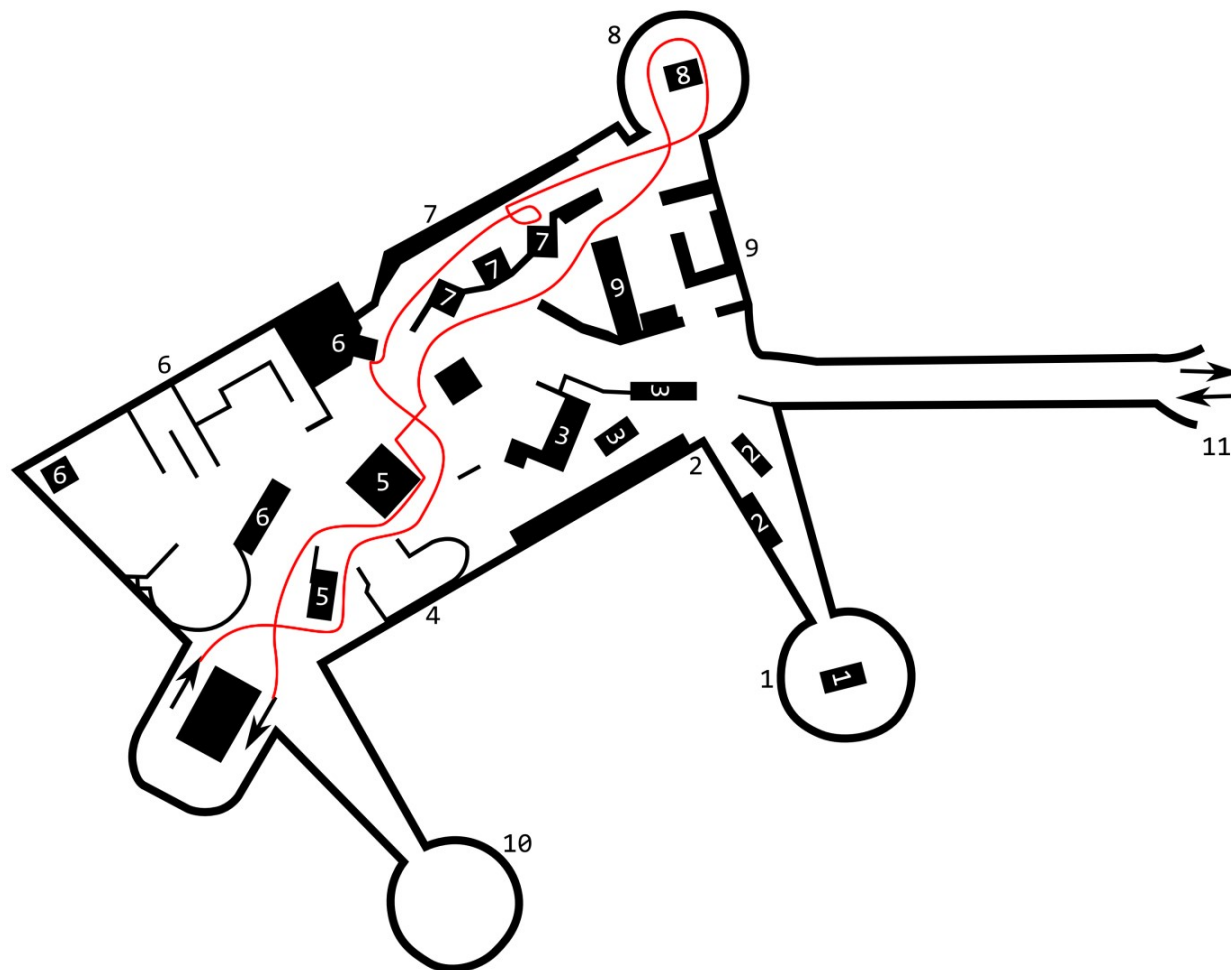
Track 19

Visitor Track Number:				19		
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/28/2015		Weekday:	Saturday		
Des cription:	2 boys, siblings or cousins with grandparents					
Individual Demographics:	Gender:	Male	Attitude:	Calm		
	Age:	10				
Group	# adults:	2	Leader:	Child		
Demographics:	#children:	2	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:18					
THA	10:20	10:47	0:27	11	0:02	
TEG	10:47	10:53	0:06	5	0:00	
SPW	10:53	11:24	0:31	17	0:00	
NGC	11:25	11:33	0:08	5	0:01	
SPW	11:37	11:41	0:04	1	0:04	
BBQ	11:45	11:47	0:02		0:04	
LGR	11:47	12:33	0:46		0:00	
CAF	12:33	12:57	0:24		0:00	
SHP	12:59	13:00	0:01		0:02	
THA	13:01	13:03	0:02	2	0:01	
SCS	13:03	13:04	0:01	1	0:00	
SPW	13:05	13:28	0:23	7	0:01	
SCS	13:28	13:30	0:02	1	0:00	
THA	13:32	13:44	0:12	1	0:02	
NGC	13:46	13:47	0:01	1	0:02	
EXT		13:48			0:01	
Total Time		3:30		52		

[illegible]

SPW	8	11:08	11:09	0:01		0:00	1			1								1	
SPW	13	11:09	11:10	0:01		0:00					1						1		Grandfather shows him how to throw Aussie rules football, boy did it, Grandpa congratulated him
SPW	5	11:11	11:12	0:01		0:01	4											2	
SPW	12	11:13	11:14	0:01		0:01												1	Watched others do race
SPW	13	11:14	11:17	0:03		0:00	1									1	1	1	
SPW	12	11:17	11:18	0:01		0:00	2				1							1	
SPW	6	11:19	11:19	0:00	0:02	0:01													No interaction
SPW	10	11:20	11:24	0:04	0:01	0:01	4					4					1		Actually didn't jump the gun when racing against cousin
NGC	5	11:25	11:26	0:01							1					1	1		Lego city/bike
NGC	6	11:26	11:28	0:02	0:05	0:00					1						1		Excavator- Grandpa helping
NGC	7	11:28	11:30	0:02	0:04	0:00	3												
NGC	8	11:30	11:32	0:02		0:00							2						
NGC	5	11:32	11:33	0:01		0:00								3		1			
SPW	12	11:37	11:41	0:04														1	Just stood with grandparents and watched for a while
THA	17	13:01	13:03	0:02													1	1	
THA	16	13:03	13:03	0:00		0:00								1					
SCS	1	13:03	13:04	0:01							1							1	
SPW	10	13:05	13:06	0:01	0:01		3					3						1	
SPW	13	13:07	13:07	0:00		0:01												1	
SPW	8	13:07	13:09	0:02		0:00				1								1	
SPW	10	13:09	13:09	0:00	0:01	0:00	1					1							
SPW	12	13:10	13:19	0:09		0:01	1					1						1	Grandma took photo/video of him
SPW	3	13:20	13:26	0:06		0:01	12					5		16			1	1	Grandma explaining to him what to do at the eye exhibit. Wasn't really getting it. Grandpa read grip instructions
SPW	6	13:26	13:27	0:01	0:02	0:00	3				3								
SPW	9	13:27	13:28	0:01		0:00						1					1	1	
SCS	1	13:28	13:30	0:02							1						1		1
THA	12	13:32	13:44	0:12	0:01							3	3					3	Watched cousin. Him and cousin kept switching turns
NGC	11	13:46	13:47	0:01			2								1	1		6	Watched all trains

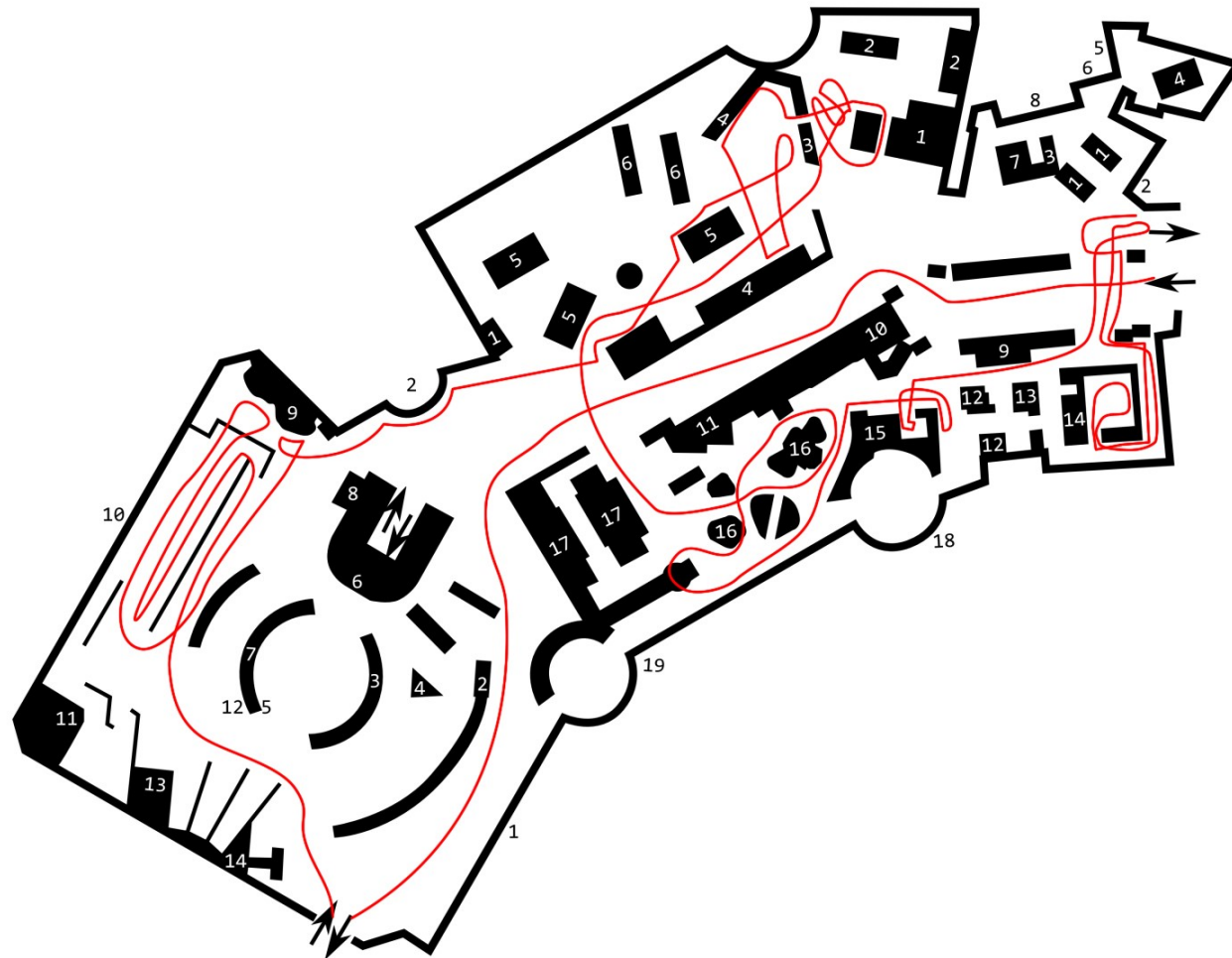


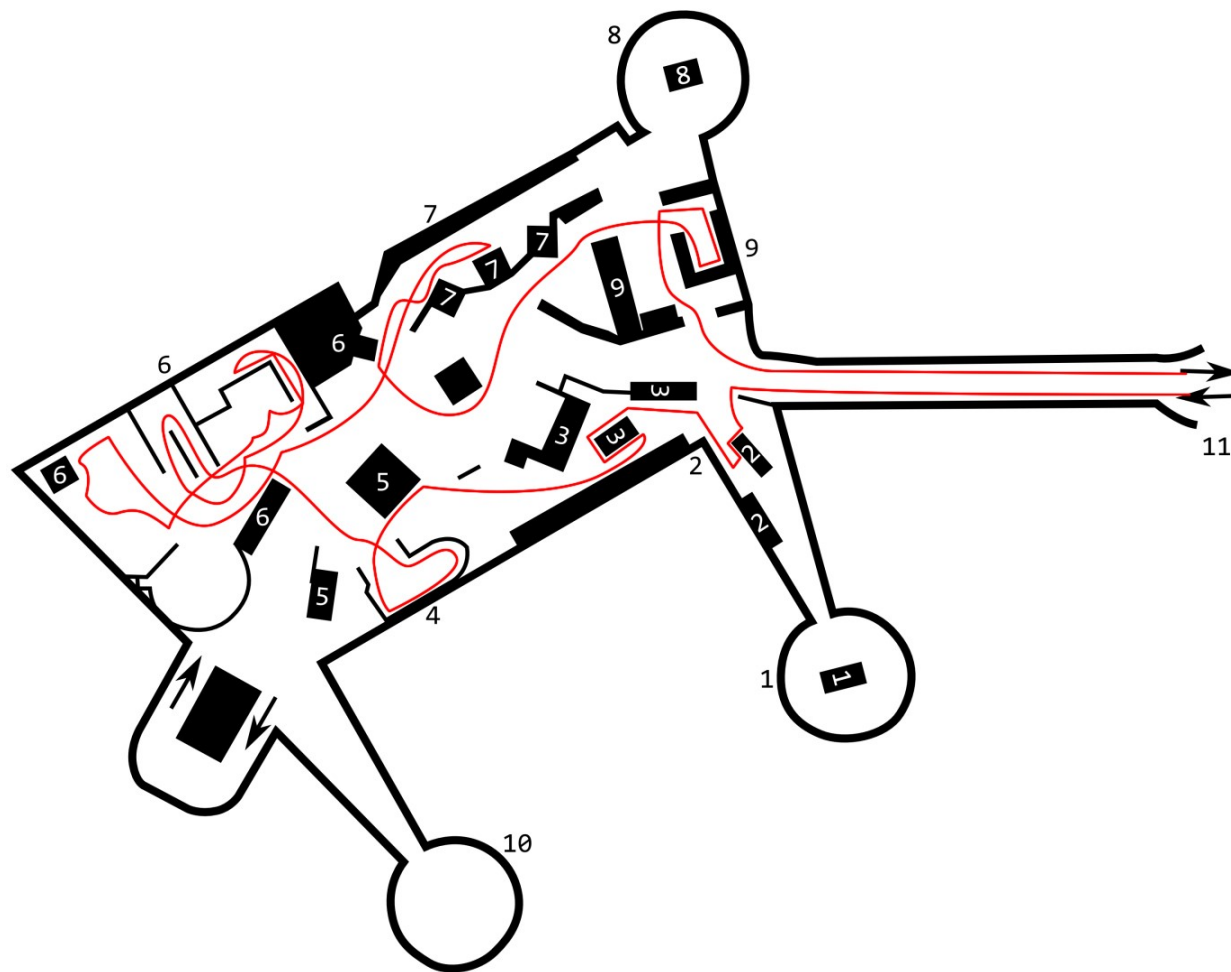


Track 20

Visitor Track Number:			20			
Investigator:	Zach/Michelle		Location:	Scienceworks		
Date:	11/28/2015		Weekday:	Saturday		
Description:	Young girl with younger brother and mother as well as a another family member (grandmother or aunt)					
Individual Demographics:	Gender:	Female	Attitude:	Calm		
	Age:	9				
Group Demographics:	# adults:	2	Leader:	Adult		
	#children:	2	School?:			
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	14:11					
SEG(SPW)	14:13	14:19	0:06	1	0:02	
NGC	14:21	14:47	0:26	9	0:02	
MPL	14:51	15:46	0:55	1	0:04	
SPW	15:46	15:50	0:04	4	0:00	
SCS	15:50	15:50	0:00	1	0:00	
TEG	15:50	15:55	0:05	6	0:00	
THA	15:56	16:06	0:10	5	0:01	
SHP	16:07	16:14	0:07		0:01	
EXT		16:16			0:02	
Total time		2:05		27		

[illegible]



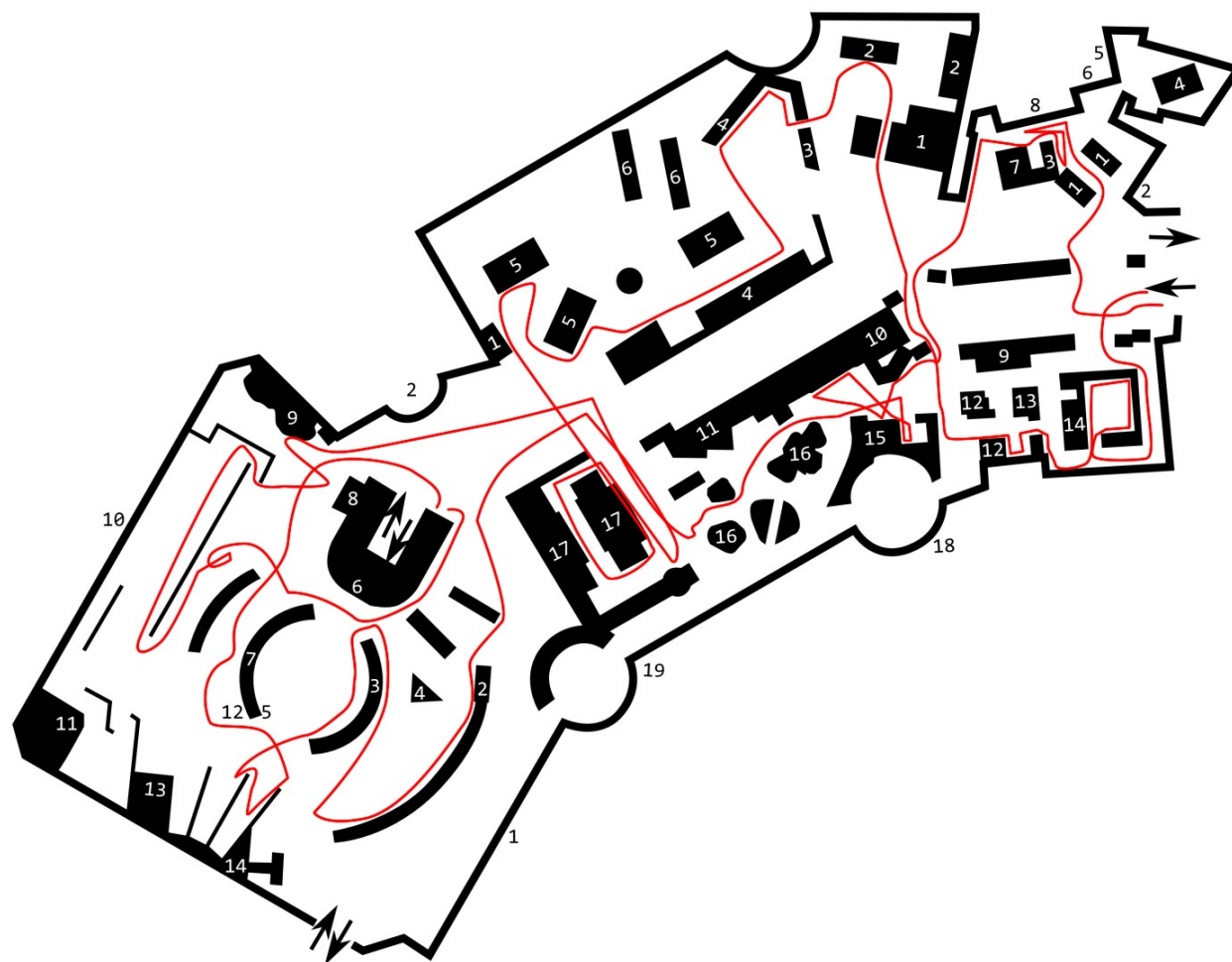


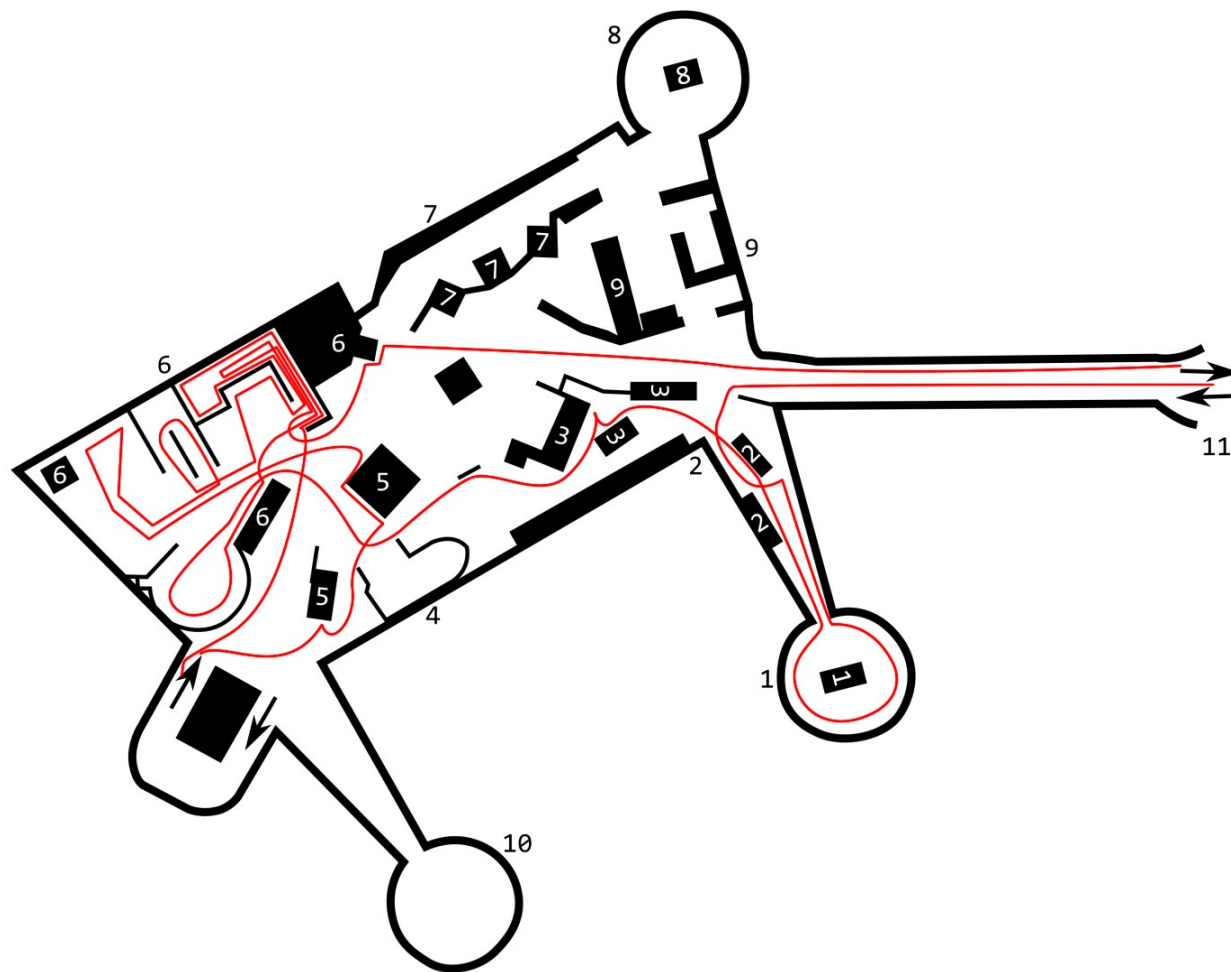
Track 21

Visitor Track Number:			21			
Investigator:	Zach/Michelle		Location:	Science works		
Date:	11/29/2015		Weekday:	Sunday		
Description:	Boy with younger brother, mom, dad and grandfather					
Individual Demographics:	Gender:	Male	Attitude:	Calm		
	Age:	10				
Group Demographics:	# adults:	3	Leader:	Adult		
	#children:	2	School?:	No		
Area Code	Time in	Time out	Duration	Stops	Transit Time	Notes
ENT	10:24					
THA	10:27	10:43	0:16	2	0:03	
TEG	10:43	10:52	0:09	4	0:00	
THA	10:53	10:56	0:03	1	0:01	
SPW	10:57	11:16	0:19	6	0:01	
NGC	11:17	11:35	0:18	2	0:01	
SEG	11:41	11:49	0:08	1	0:06	
LGR	11:51	12:30	0:39		0:02	
CAF	12:32	12:58	0:26		0:02	
THA	13:01	13:22	0:21	8	0:03	
SPW	13:22	13:32	0:10	5	0:00	
NGC	13:34	13:59	0:25	4	0:02	
EXT		14:07			0:08	
Total Time		3:43		33		

Visitor Track Number:							21																				
Code							P	P	T	L	L	O	A	B	E	O	D	O	R	T	H	O	A	H			
							U	U	I	E	U	R	O	A	H	I	C	D	E	E	O	C	T	E			
							S	L	R	F	G	C	M	D	T	I	N	O	C	A	X	T	P	C	A		
							H	L	N	T	S	H	S	Y	E	T	T	N	O	D	T	O	L	H	R	Notes:	
Exhi bit	Exhib it #	Time in	Time out	Durati on	Optimal Time	Transit Time																					
THA	14	10:27	10:33	0:06			10						1		1				1	1					1	2	Did soundscape with grandpa and dad. Sat in there a decent length
THA	12	10:34	10:43	0:09	0:02	0:01								1	1				1							2	Did it once himself then watched his brother do it a few times
TEG	1	10:43	10:44	0:01											2												2 crawls through
TEG	2	10:44	10:45	0:01		0:00				2									1	1							
TEG	4	10:45	10:48	0:03		0:00	1		4										2					1	2		Looked in many door. Photo taken
TEG	5	10:48	10:52	0:04		0:00						1	2						1	1			1	1			
THA	17	10:53	10:56	0:03			1		1																		Mostly just walked through rotating tunnel
SPW	2	10:57	11:00	0:03				1			2	1		1					4	1					1		Did several activities on the wall with dad
SPW	3	11:00	11:05	0:05		0:00	2	2		1			1			14			3	1					2		Pulled the rope two times. Watched all family members pull it. Hand eye with brother. Grip
SPW	5	11:05	11:06	0:01		0:00	4												1						3		Watched heart pumping exhibit
SPW	13	11:06	11:10	0:04		0:00							4						1						1		Threw all different balls. Dad tried to help. Watched grandpa do it
SPW	10	11:10	11:14	0:04	0:01	0:00	1			5				2			1		2	5							Raced and looked at the different food for being healthy...lifted and read each flap with family
SPW	7	11:14	11:16	0:02		0:00					2														1		
NGC	5	11:17	11:19	0:02			10											1		1	1						Parents and grandparents very involved
NGC	6	11:19	11:35	0:16	0:05	0:00	1	6		5			1		1				2					1	1		Building wall putting blocks in
SEG	1	11:41	11:49	0:08			1		2			2	1						3	2							Read eye test. Turned the hypnotizing wheels for a long time

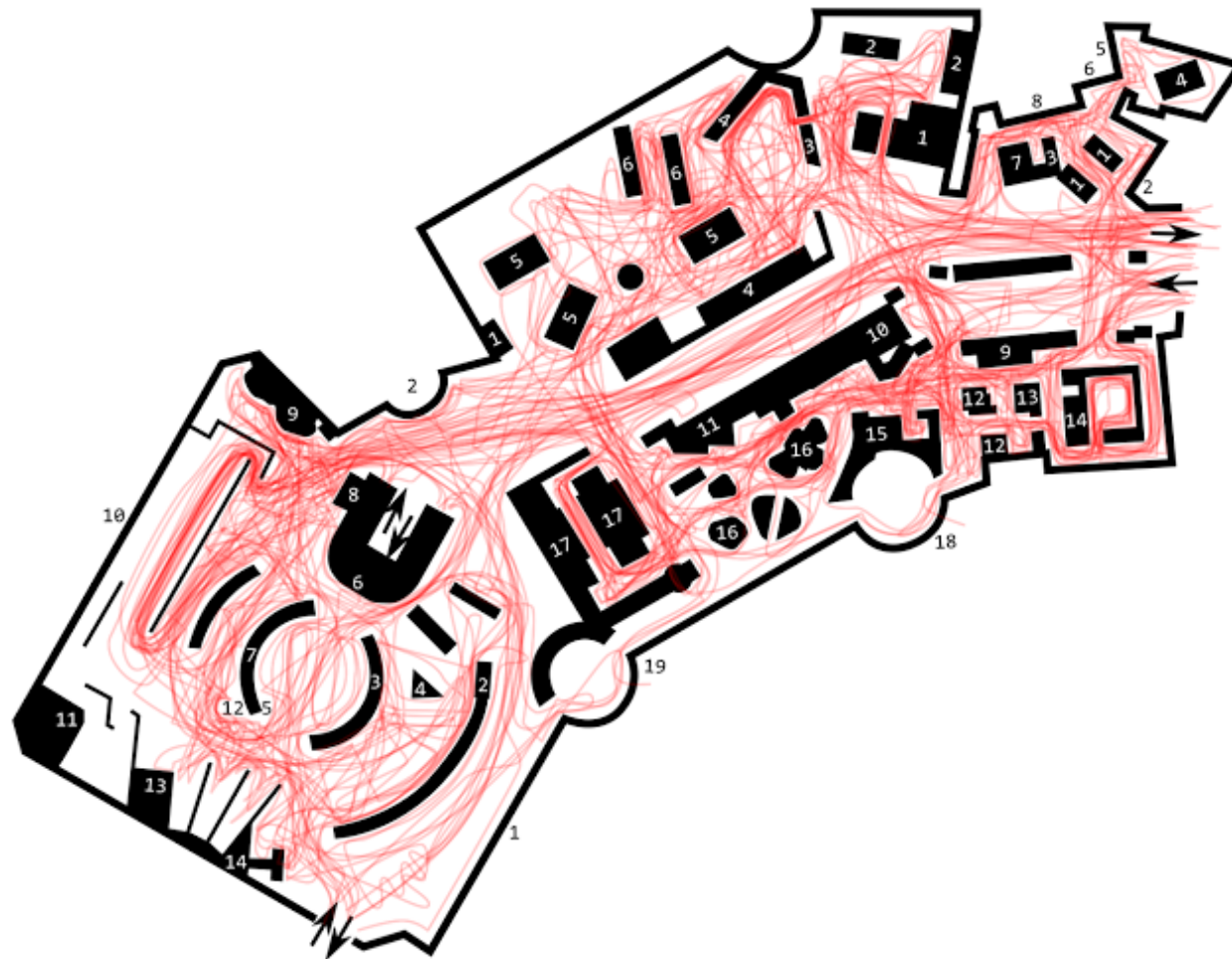
[illegible]



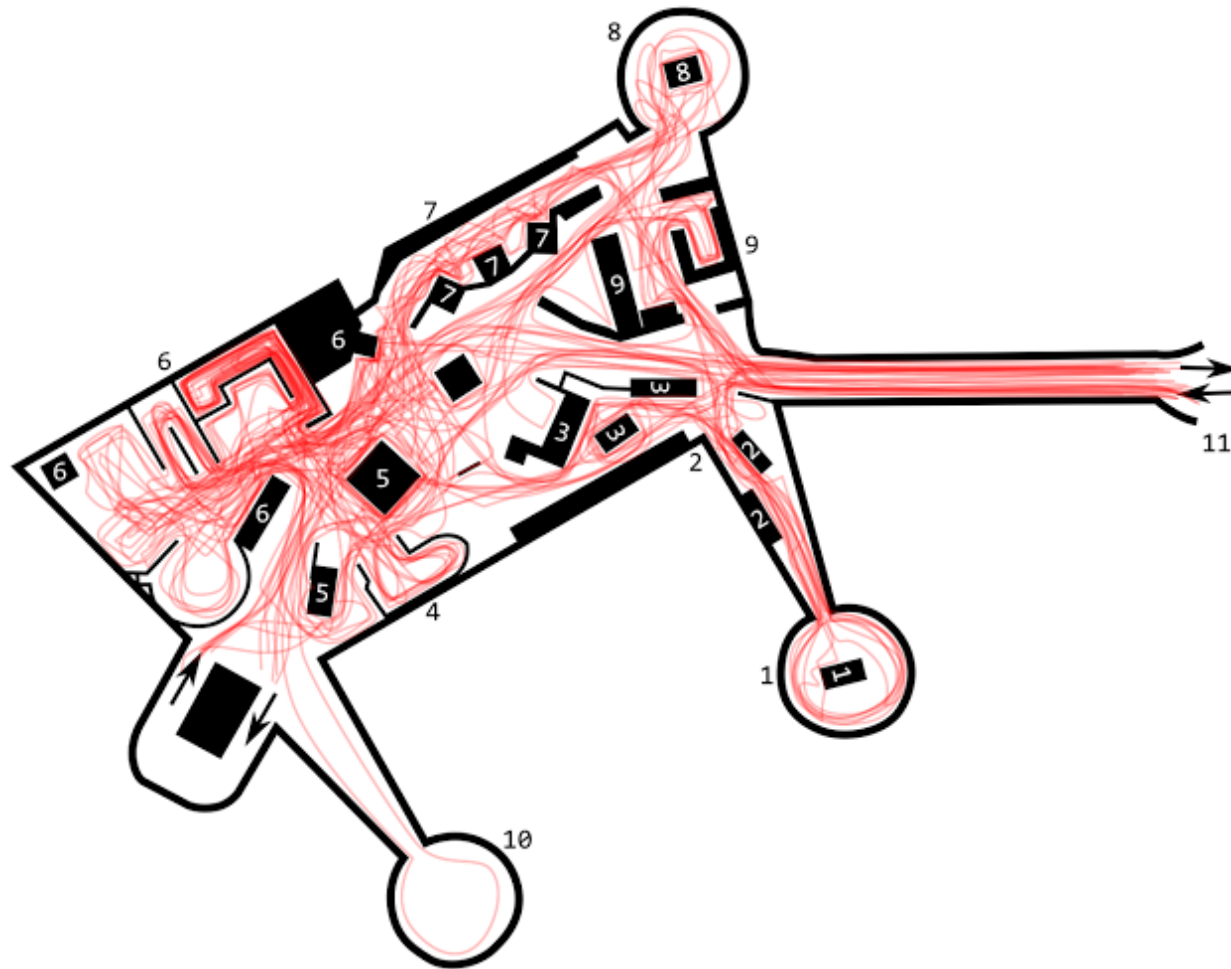


Overlay of Tracks 1-21 for the First & Second Floor

First Floor



Second Floor



Appendix G: Team Assessment

At the beginning of the term, we decided to divide up the labor in order to maximize efficiency. We split into two teams: the tracking team and the data analysis team. This allowed us to keep the specific scoring aspect of the analysis blind from the tracking team so that the data was not biased. The division of labor helped our team stay focused despite the number of different tasks that needed to be accomplished on a given day.

Our slightly unique team structure meant that we often worked from different locations to maximize productivity. To ensure that we all remained on the same page, the team developed an agenda on a daily basis. Occasionally, if we had several tasks, the agenda was even sent out in email to all team members, complete with diagrams and checklists. At the conclusion of each tracking day, both teams checked in with each other in person to guarantee that all requirements were met for the day. Frequent team evaluations completed in person left all channels of communication open between team members to express their thoughts. Care was taken to ensure that both the tracking and non-tracking parties were satisfied with the work being done, and the division of labor. Throughout the process, ideas were shared among team members regarding writing, analysis, tracking performance, and thoughts and opinions. Some ideas, such as analyzing the correlation between time at exhibits and engagement score were brought about by the tracking team. The tracking team developed a different perspective from the data analysis team due to the daily observations at the museum. The division of labor led to two different perspectives, which allowed us to have a wide range of conclusions and findings.

We would often debrief after key meetings with advisors and sponsors, and even after submitting some assignments to determine the best course of action. In one case, this led to more questions, or confusion, and we wrote down our thoughts into a comprehensive email and awaited a response from the advisors. Beyond email correspondence, one of our challenges was communicating exactly how engagement scores were calculated to both our advisors and our sponsor, Carolyn. In order to ensure that everybody was on the same page, we had a meeting with our sponsor to fully describe the process. Through a presentation and step-by-step explanation, Carolyn successfully understood our methods and the meaning behind them. In order to communicate this process to our advisors, we provided a step-by-step explanation as well as equations in our methodology. Another challenge we encountered this term was making sure that Carolyn was satisfied with the number of tracks we completed. Typically, forty tracks are completed for studies conducted at Museum Victoria, cumulating approximately sixty hours. Our team completed twenty-one whole of site tracks; however, these tracks totaled approximately sixty hours as well. After meeting with Carolyn and discussing the number of hours spent tracking, we agreed that our number of tracks was sufficient.

In summary, our team encountered many challenges unique to IQP, but applicable to the teamwork in the rest of our lives. All challenges were coped with effectively and the team managed to overcome any and all setbacks. Writing critiques by advisors and fellow teammates on nearly a daily basis kept us all working at our highest standards. As two terms of work in the same four-person teams draws to a close, we can safely say that we learned a lot about ourselves and how to work with others in the project environment.