April 2006

The Design and Implementation of Visitor "Traces"

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The Launch Pad Redevelopment

The Design and Implementation of Visitor "Traces" for the Launch Pad Gallery in the London Science Museum

An Interactive Qualifying Project Report to be submitted to the faculty of
Worcester Polytechnic Institute in partial fulfillment of the requirements for the
Degree of Bachelor of Science

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April 28th 2006

Acknowledgements

Upon completion of this project, there are many people who we owe a great deal of thanks. First, we must acknowledge Alex Burch for the time and effort she devoted to helping us with our project. We are extremely thankful for the "brilliant" ideas she offered and her openness to our ideas. Emily Bick also deserves a lot of thanks for the helpful guidance offered along the way. We also would like to thank Glenn Murphy, Virginia Price and Jin Norwal for all their help in getting our prototypes on gallery. A special thanks goes out to Gareth Jones for his much needed help in creating our awesome "Magnetic Wall". Also a thanks to Anthony Richards and his Launch Pad knowledge as well as London advice although we never did get to try Marmite. And we must not forget the "infamous" (at least to us) Ben Gammon and his endless un-dated papers. We still ponder how many papers he wrote while working at the LSM. And may we not forget the "office nose".

We also would like to acknowledge our project advisors Rick Brown and Scott Jiusto for also providing us with constructive feedback. We sincerely appreciate all the help and encouragement you offered over the 14 weeks of this project.

Abstract

In assisting the London Science Museum in the redevelopment of their Launch Pad gallery, this project researched the concept and applications of "trace". Trace, which is a way for visitors to leave behind a reminder of their visit, was determined to have noticeable effects on visitors' behaviour and engaged learning. Upon conclusion of observations and interviews conducted while three designed prototypes were on gallery, guidelines for the implementation process were created along with specific recommendations for the new Launch Pad gallery.

Executive Summary

The London Science Museum is currently undergoing a redevelopment process called the Science Museum Master Plan through which they will reinvent the Launch Pad gallery. The new Launch Pad is scheduled to open in December 2007. While the current Launch Pad gallery is highly successful, the museum plans to develop new innovative exhibits, increase the level of interactivity, and incorporate "trace" in the new Launch Pad. Trace is a way for visitors to leave something behind; it allows them to personalize the gallery while expanding their own experience. The goal of this project was to assist the London Science Museum in planning for trace in the new Launch Pad. This was done by researching the many ways trace has been used in other museums, designing and testing trace concepts through the use of prototypes in the current Launch Pad, developing general guidelines for incorporating trace, and finally by providing specific trace recommendations for the new Launch Pad.

Because trace is a relatively new concept, there were no books, reports or how-to guides about trace for us to use while researching trace or to follow when designing our prototypes. We tackled the design process while noting all the important issues and considerations about implementing trace in a museum. The guidelines we created outline our trace development process and all the considerations that may be important in the implementation and assessment of trace in a way that other museums can follow.

We first researched and compiled a document containing a list of contemporary examples of trace. The trace compilation contains a description of each trace and a matrix, which outlines the categories that each trace falls into. The intent was to create a common reference of traces known to the Science Museum and us.

Based on our research and development of a general trace development process, we then designed, implemented, and assessed the success of three trace prototypes in the existing Launch Pad. Due to the time restraints and budget of the project, the three prototypes were relatively simple, inexpensive and easy to implement. Each prototype was designed to test different concepts and roles of trace. Once on gallery, the traces were assessed through the use of observations and interviews. At least 70 observations and 20 interviews were collected for each trace along with analysis of visitors' creations.

Through our observations and interviews, it was concluded that the simple trace prototypes did have noticeable measurable effects on visitors' behaviour and that visitors'

generally enjoyed the trace experience. It was also concluded specifically from interviews with visitors, that they wished there were more visitors' contributions on display. Analysis of the quantitative results from the observations and interviews also suggested that trace could cause noticeable improvements in engagement times, quality and quantity of responses, and types of discussion.

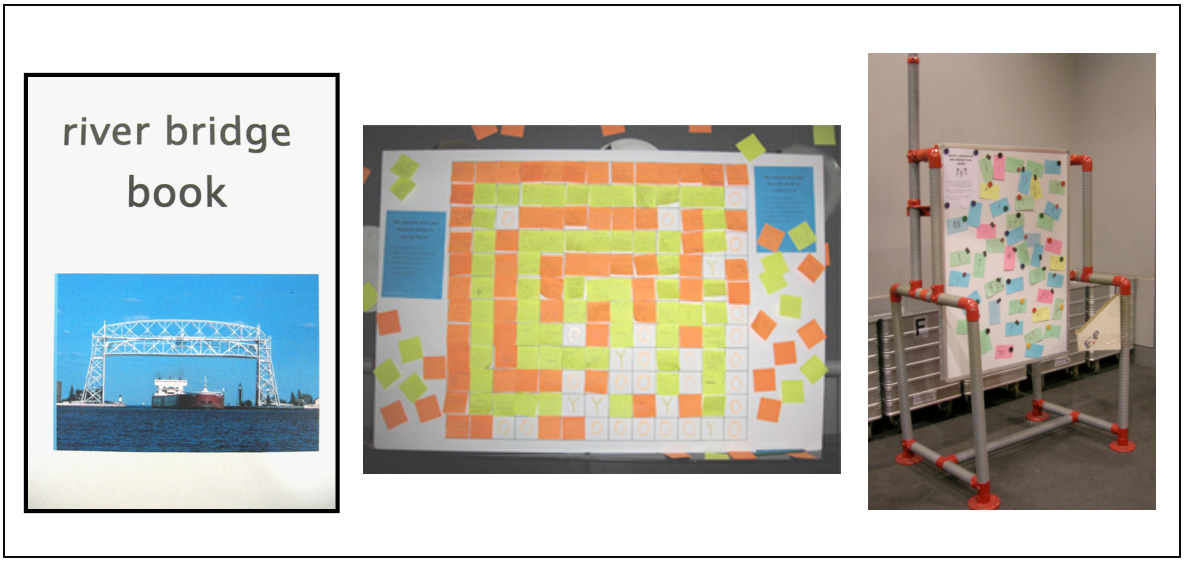

Figure 1: Trace Prototypes

In addition to the guidelines, we presented the London Science Museum with recommendations of trace to include in the new Launch Pad gallery. The recommendations, like the guidelines, are a summation of the outcomes and considerations of our own implementation research. Included in the recommendations are trace possibilities that can be used in conveying concepts tested by our simple low-tech prototypes.

The final deliverables of this project, guidelines for implementation and the recommendations for trace in the new Launch Pad, contain valuable information about creating effective trace. These documents are intended be used in the creation of more effective innovative traces. Although high-tech possibilities are presented, our research and experiments in the current Launch Pad showed that the simple, inexpensive, easy to implement traces can be effective. Trace can be used to accomplish many goals in a museum gallery. The incorporation of trace in the new Launch Pad will reinforce the visions and goals set forth for the redeveloped gallery.

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Compilation of Known Traces
Guidelines for the Design and Implementation of Trace
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Chapter 1: Introduction

Since the 1920's, the London Science Museum (LSM) has strived to improve the levels of interactivity offered by their exhibits with the goal of increasing engagement and learning (Burch, 14/3/06). As part of the most recent redevelopment plan the museum has targeted the Launch Pad gallery, which is the museum's most popular interactive gallery. Scheduled to open in December 2007, the new Launch Pad will contain 60 hands-on exhibits that are a combination of improved existing exhibits and new innovative exhibits. The redeveloped gallery will incorporate new approaches to enhancing visitors learning.

In redeveloping Launch Pad, the museum will expand the learning opportunities offered in the gallery by including "trace". Trace will allow visitors to reflect on what they've done while interacting at the exhibits and allow them to leave behind a reminder of their visit. It also creates an opportunity for visitors to see who has been there and view their thoughts. The inclusion of trace in Launch Pad is expected to offer a rewarding experience, promote creativity, and increase visitor engagement.

The London Science Museum is among many other museums and institutions that have attempted to increase visitor learning through the use of a trace. The museum has already implemented trace in their Energy gallery and Wellcome wings with the Energy Ring and the Worm Wall. Other museums such as the Victoria & Albert Museum, London UK, have offered visitors places to discuss their views and post them for others to see. Even though the concept of trace had been included in many museum galleries, there are no formal guidelines that direct the development of trace. In developing traces for the new Launch Pad, the Science Museum is curious about the effects of trace on visitor behaviour. There have only been a few studies conducted to assess whether trace is successful in accomplishing the objectives of the museum and the visitors (Gammon, n.d.)

The goal of this project was to assist the London Science Museum in planning for trace in the new Launch Pad. One aspect of the project was to compile and examine the range of traces that exist in other museums. The project also included creating low-tech trace prototypes that were implemented and tested in the existing Launch Pad. The prototypes were assessed to determine their effects on visitor behaviour and engaged learning. Finally, the LSM was presented with guidelines for implementing trace and a list of recommendations of traces to include in the new Launch Pad. The recommendations were developed specifically for the

redevelopment project while the guidelines were created with future trace endeavors in mind. We hope that all of the research completed on trace will inspire the museum and hopefully other museums to incorporate trace into their galleries.

Chapter 2: Background

The London Science Museum is undergoing a wide redevelopment process called the Science Museum Master Plan through which they will reinvent their existing Launch Pad gallery to include trace. Trace is an interactive experience that results in the visitor leaving some aspect of their experience behind at the museum, almost as though they are marking their presence. This chapter will examine the history of the interactivity, the history of the London Science Museum, the current Launch Pad, and plans for the new Launch Pad, concepts and approaches to trace and contemporary examples of trace. These topics will introduce the background concepts for understanding the idea of trace and the museum's motivation for including it in Launch Pad.

2.1 London Science Museum

Science museums would like to change the pattern of visitors' museum visits by continually updating and offering new learning experiences. The London Science Museum does just this through their 2000 hands-on exhibits and 10,000 artifacts spread throughout its seven floors. The London Science Museum has won the Visitor Attraction Awards in 2001 and 2002 and captures the attention of 2.7 million visitors per year (London Science Museum, 2005). All of this success is undoubtedly a result of their ability in creating highly educational and interactive experiences.

Figure 2: Main Entrance to the London Science Museum

2.1.1 History of the London Science Museum

The mid-nineteenth century was a period of re-organization of science and technology education. Prince Albert had a prominent role in this plan and was largely responsible for the Great Exhibition of 1851, which highlighted the successes of modern science and technology. Due to the Exhibition's huge success, there was a surplus of £186,000 that was then used to found three new museums, which are currently known as the Victoria and Albert Museum, the Science Museum, and the Natural History Museum (Wikipedia, 2006).

The Science Museum was originally the Science Collection at the South Kensington Museum, which was founded in 1857. In 1928, the Science Museum was given its own building which it uses to this day to house its growing number of collections. The Science Museum is one of four museums collectively known as the "National Museum of Science & Industry" (NMSI). The other three museums are the National Railway Museum, the National Museum of Photography, Film and Television, and the Science Museum Wroughton.

NMSI's mission is "to promote the public's understanding of the history and contemporary practice of science, medicine, technology and industry" which they achieve by "engag[ing] people in a dialogue to create meaning from the past, present and future of human ingenuity" (Hewitt, 2002). For the London Science Museum, the preceding mission statements are the basis for a hands-on learning approach, which allows the visitor to explore and take the necessary steps to come to a personal conclusion, rather than just be presented with the answer.

2.1.2 History of Interactivity

One of the key design goals of the new Launch Pad gallery is to provide interactive learning opportunities to visitors in the 8-14 age group. Interactive learning is a modern idea, however, and reflects a large philosophical change from the original approach of static museum exhibits. This section provides a brief history of the trend towards interactive learning in modern museum exhibits.

The first interactive science centre geared toward embracing Piaget's theory of interaction was the Frank Oppenheimer Exploratorium in San Francisco established in 1969. The museum's mission is to "nurture curiosity in the world around us" (Exploratorium, 2006). The museum currently gets more than 110,000 visiting school children to the museum per year. As a result of this monumental achievement, many museums and centres have followed in its footsteps (Volunteer Center, 2006). The Exploratorium proved that an interactive visit to a museum allows children to gain knowledge in a manner unconventional to what they are typically accustomed to. Not only do children learn on their visits but it inspires return visits to have fun and learn even more.

One such museum that was influenced by the success of the Exploratorium was the London Science Museum. When the London Science Museum opened it was well known for the scientific artifacts it displayed, however, there weren't any traces of the interactive experiences it

is so well known for today. Interactivity in museums was a concept that only first came to life in the 20th Century, and The Exploratorium's success was the proof supporting the concept.

Directly inspired by the Exploratorium the London Science Museum took their Children's Gallery and reinvented it into a gallery that would be directed at educating children purely using interactive tools, this gallery was then renamed Launch Pad. The current Launch Pad, which is the museum's largest interactive exhibition and most popular gallery, opened in 1986. The gallery was the first wholly interactive and staffed gallery in the world to focus on technology in addition to scientific phenomena. Since Launch Pad's initial establishment it has been moved and redeveloped several times yet it still maintains the same goal of the education of children through interactivity.

Since the success of Launch Pad the museum has developed many more interactivity based galleries. The latest interactive gallery is the Energy Gallery developed in 2004 on the 3rd floor of the museum, which teaches how energy powers every aspect of our lives. The gallery teaches using computer-based exhibits and gives the feel of an "energy playground"; this gallery has been a success as well. Now twenty years after the original establishment of Launch Pad the museum has set its sights once more on their first interactive gallery. There are current efforts to redevelop and upgrade Launch Pad once more so that it can continue to teach and entertain visitors.

2.1.3 Current Launch Pad

The aim of the Launch Pad is to make science and technology accessible, enjoyable and understandable to visitors through the provision of active, social and fun experiences. Launch Pad promotes self-confidence when dealing with topics that are scientific and technology based (Jackson, 1998). The gallery always aims to create a child and family friendly experience that cannot be replicated at home.

Figure 3: The Launch Pad Gallery

At the present time Launch Pad is located in the basement of the museum (Figure 3) where it presents its content in an exciting way by offering 50 unique "hands-on" experiences.

The core exhibits that host these experiences can be seen in Figure 4 below. The gallery covers six specific themes of science: Energy, Electricity, Forces, Light, Materials and Sound. Within these themes, there are exhibits that focus on conveying concepts by allowing visitors to observe and manipulate the phenomena. The exhibits allow visitors to see and feel the effects while learning to experiment in a fun and exciting manner. In order to help visitors get more out of their visit, the gallery is staffed with Explainers. Explainers' aid the learning process by assisting visitors through difficult content and guiding visitors' thought processes.

The exhibits in Launch Pad encourage and specifically reinforce science content that children learn in school. The learning objectives of each exhibit are derived directly from the National Curriculum for key stages two and three (summarized in Appendix A). The Launch Pad gallery is intended to help children demonstrate the concepts they learn in school in a more hands-on environment than most schools could provide.

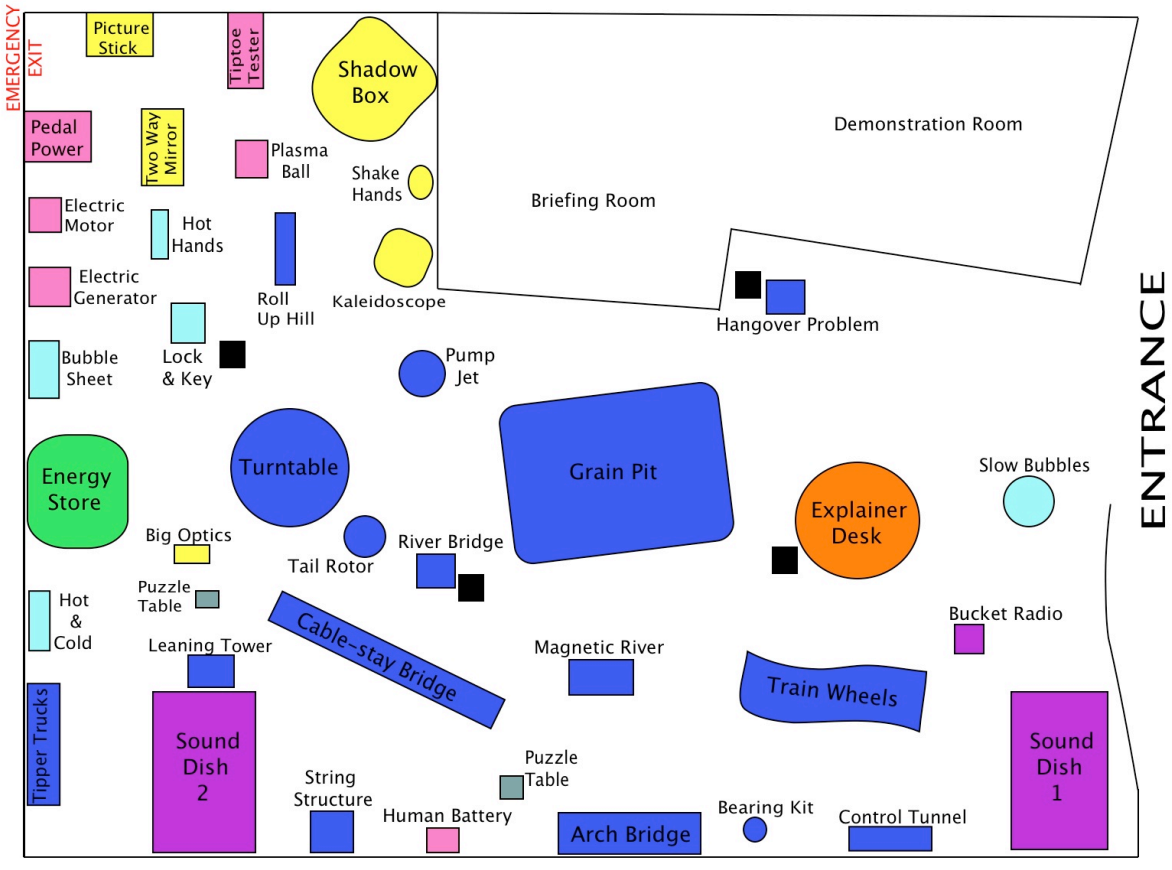


Figure 4: Current Layout of Launch Pad

2.1.4 New Launch Pad

In order to reestablish Launch Pad as the leading innovative hands-on gallery in the UK, the Science Museum has begun the Launch Pad redevelopment project. The project is a small part of the Museum's overall redevelopment plan and is set for completion in December 2007. The new Launch Pad gallery will be moved out of its hidden basement location and placed on the third floor of the museum. In its new location, Launch Pad will be expanded and enhanced through alterations such as updated content and innovative new exhibits.

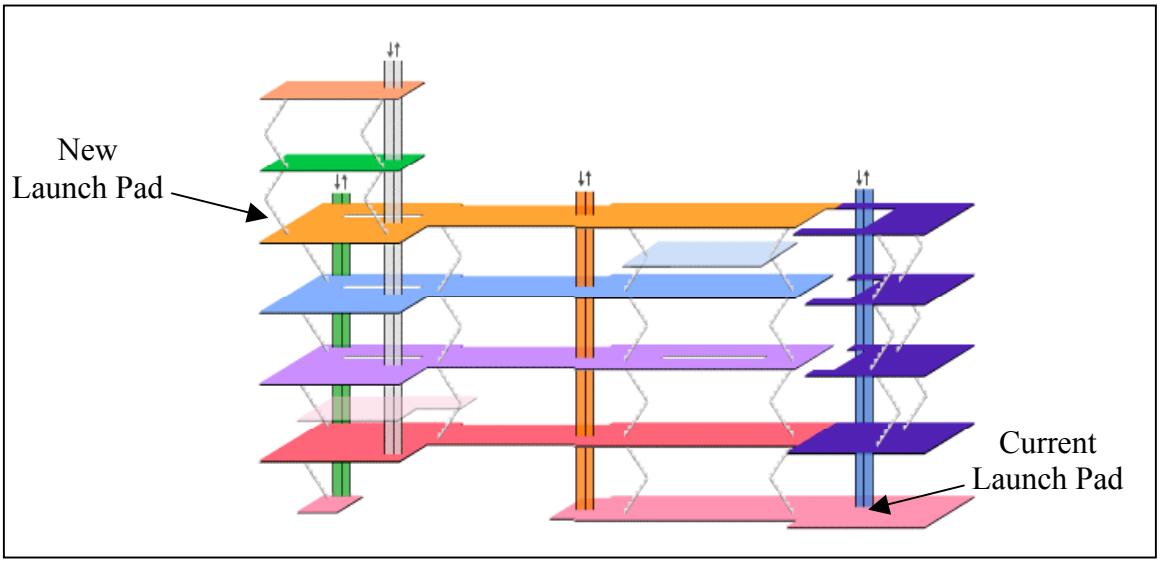


Figure 5: Science Museum Floor Plan

The new Launch Pad will be a combination of improved existing exhibits and new open-ended exploratory exhibits that have highly visual and intriguing content. The new Launch Pad will be more directly connected to the science being taught in schools in the United Kingdom.

In order to enhance the learning in Launch Pad, the Science Museum has decided to integrate trace. The concept of trace is designed as a way for visitors to leave something behind. As some life experiences, such as littering, graffiti, or camping, discourage the act of "leaving a trace", this form of trace is encouraged. A trace is intended to increase the level of learning in interactive exhibits. The museum aspect of a trace is seen as a form of representational action. Stevens and Hall (1997), who developed their own form of trace, describe trace as being the visitor's interpretation in a physical form, which results from the impact of the experience on the visitor.

The experience created in participating in the trace will help to consolidate and increase knowledge of the material at hand. It will probe the person into reviewing what they have just seen and allow them to remember the experience easier. Implementing trace is an ideal way to make knowledge committed to long-term memory and hopefully at the same time result in leaving a thirst for more knowledge.

2.2 Trace: Concepts and Approaches

The London Science Museum has decided that they would like to incorporate trace into the new Launch Pad. So far trace seems like a "perfect" solution to enhancing the museum experience, but why is trace the answer? This section examines what exactly it is about trace that makes it the right choice for the Launch Pad gallery.

2.2.1 The Need for Trace

There are many aspects that make up a visit to Launch Pad such as the setup and atmosphere of the gallery, the visitors' prior knowledge and eagerness to interact, and many social interactions. Trace will have an important role in enhancing this "interactive experience".

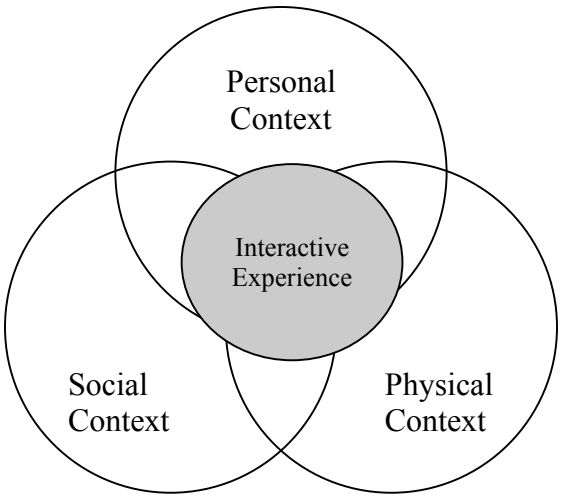


Figure 6: The Interactive Experience Model (Falk, 1992)

The Interactive Experience Model

The Interactive Experience Model developed by Falk and Deirking is a framework that interprets the complexities of the museum experience. The model (Figure 6) addresses the three main aspects, personal, socio-cultural, and physical contexts, which affect how much a visitor learns in a museum and how the learning occurs. The contexts are important things that trace will utilize to enhance the experience.

***Personal context*:**

Each visitor has a different background, level of understanding and interest as well as willingness to learn that will affect the learning outcome. The outcome is also affected by the amount of personal control allowed by the exhibit, such as choice and control over the end result.

Trace can be altered to incorporate many visitors' personal context. Although, traces in the new Launch Pad will be aimed at the target audience, children ages 8-14.

Socio-cultural context:

Visitor learning is greatly enhanced by interaction and collaboration. Social collaboration in museums consists of two types of interactions. Interaction with learning facilitators and visitor interaction with other groups who are currently sharing in the same experience which both influence the educational process.

The importance of social learning is illustrated in the museum's plan of integrating social collaboration into new exhibits. In Launch Pad, it will be essential to consider the effect of Explainers and other visitors on each persons learning experience. Trace will hopefully further these social interactions.

***Physical context*:**

The physical and visual content of an exhibit can affect the level of visitor comprehension. Ease of operation, arrangement, logic of setup, and overall exhibit design play a part in effective learning. Events that occur after visiting the exhibit also affect long-term retention (Falk, 2005).

Trace, in the new Launch Pad, will tie these three contexts together while directing the visitors' attention towards important science concepts presented in the gallery.

Theory of Inquiry

Along with the Interactive Experience Model, the Theory of Inquiry presents a basis for trace and why it is important to incorporate in the new Launch Pad. The Theory of Inquiry presents a continuous process, which is driven by the reconstruction of ideas (Ansbacher, 2000). The process involves using the scientific method as a teaching tool.

Learners are first encouraged to develop their own viewpoint and then test it through interaction and observation. Then their original hypothesis is either confirmed or found to be false. In the final stage of the process, curiosity and further inquiry are inspired. The inquiry learning process, Table 1, outlines the steps of a visitor's interaction with phenomena they have never confronted.

Inquiry Learning Process

1	Confrontation with the initial puzzle
2	Investigation and analysis of the scientific concept
3	Modifications and changes are made to previous beliefs
4	Solving the puzzle, resulting in a deeper understanding of the concept

Table 1: Inquiry Learning Process (Stevens and Hall, 1997)

Trace will build on all steps of the process with the last step of the inquiry learning process being the main goal. In interacting with the trace, visitors will hopefully develop a deeper understanding of the concepts presented in Launch Pad.

2.2.2 Dimensions of Trace

Contemporary traces can be placed in many different dimensions. These dimensions are then broken down further into specific categories. The categories define the trace's target audience, need for facilitator and objectives of the trace. Table 2 contains the 6 dimensions and their corresponding categories.

Dimensions and Categories of Trace

Dimension	Category	Definition
1	*High Tech*	Innovative technology.
	Low Tech	Simple, inexpensive and easy to implement.
2	*Facilitated*	Needs to be staffed or attended to.
	Unfacilitated	Able to function without assistance.
3	*Exhibit Oriented*	Connected to a specific exhibit.
	Stand Alone	Not related to a certain exhibit content but to the whole gallery/museum.
4	*Structured*	Limited number of outcomes possible, if any. Focus directed at certain aspects.
	Unstructured	Very open-ended.
	Multi-Outcome	Allows for many different outcomes.
5	*Progressive*	Visitors create something and then allowing them to check the progress of the element they created.
	Collective	Outline for a predefined structure that visitors can alter or add onto in the gallery.
	Competitive	Recording visitors' performances on an exhibit.
6	*Family*	Would work better on weekends with family groups.
	School group	Able to be used in school group setting.

Table 2: Dimensions and Categories of Trace

Dimension 1: Low vs. High Tech

Trace can exist in many different forms. Within these forms, trace can be divided into low vs. high tech. Low-tech trace can be as simple as a post-it or note card left with a visitors

comment. The Gobstopper Mural at the London Science Museum was a very low-tech trace, while the Star Wars Pocket PC at the Boston Museum of Science was a very high-tech trace. Whether it is a low or high tech trace, the remaining dimensions are still the same.

Dimension 2: Facilitated vs. Unfacilitated

Trace, like exhibits, can function solo or require assistance. A trace that requires the assistance then involves issues such as staffing or parental guidance. The Gobstopper Mural at the London Science Museum was extremely facilitated in that it was staffed at all times in order to direct the behaviour of the participants. Had this trace not been facilitated, the final outcome would have been vastly different. The unfacilitated dimension of trace at the London Science Museum can be seen in the Worm Wall, Energy Ring and Save System traces.

Dimension 3: Exhibit Oriented vs. Stand Alone

A trace can be associated with a specific exhibit or the whole gallery. An exhibit specific trace can be used to reinforce certain science concepts. The use of a stand-alone trace can be used solely to personalize the gallery.

Dimension 4: Structured vs. Unstructured

Trace, like exhibits, can have various levels of structure and many different outcomes. A structured trace leaves very little open to visitor alterations or creativity. A structured trace has a set number of outcomes. The trace is designed to direct the visitor's attention to specific parts of the scientific phenomena. This is not saying that the visitor doesn't have any control but just that it is not as open-ended as an unstructured trace. An unstructured trace promotes creativity and imagination; you don't know what the visitor will do. However, there are boundaries that restrict the output of the visitor.

Dimension 5: Progressive – Collective – Competitive

Another dimension of trace is associated with the main objectives of the setup. Is the trace an ever-changing structure, a visual of multiple visitors' contributions, or a challenge imposed on visitors? A progressive trace keeps changing. The ever-changing factor allows visitors to revisit and check on the progress. It offers an incentive to see the end product. A trace that is collective requires multiple visitors' contributions to reach a final stage.

Dimension 6: Family vs. School Group

Some types of trace may work better in a family setting while other traces are designed for the school group setting. A trace that requires facilitation would be harder to use when school groups are in a gallery. Family groups (children with their parents' supervision) can engage in activities that need some facilitation.

These 6 dimensions, seen within existing traces, allow for a wide variety of traces. By altering the categories of trace, many different experiences can be offered in a gallery by trace.

2.3 Contemporary Examples of Trace

In order to develop new traces, it was essential to look at existing traces. Many examples of trace were found by searching the web and visiting museums. The London Science Museum also gave us some examples that had been mentioned in their meetings about trace. The trace examples had many different dimensions and categories. Two case studies were done on traces that displayed each extreme of Dimension 1 (high-tech vs. low-tech). By examining the "best practices" and shortcomings of each, we were able to see some issues that might arise a) in designing and implementing low-tech traces and b) in considering high-tech trace for the recommendations. The case studies were helpful in showing the difference and similarities in high-tech and low-tech trace.

2.3.1 Case Study of High-Tech Trace

London Science Museum: The Save System: The Save system is an interactive computer network employed in the Wellcome Wing at the London Science Museum. The system operates on the concept of creating a record of the visit and making it accessible on a webpage. The system is made available to users through kiosks that accompany each exhibit (Figure 7). The Save system employs a post-visit approach to increasing visitor learning. The user web pages contain all pictures created during the visit, voice recordings, and links to exhibit extensions. A fingerprint recognition

Figure 7: Save System Kiosk at London Science Museum

system is used to identify and distinguish users (Vogiazou, 2001). The following (Table 3) is a summarization of the benefits and drawbacks of the Save System.

Benefits and Drawbacks of the Save System

Benefits:	Drawbacks:
• Produces a unique record of visitor's experience • Demonstrates "cutting edge" technology • Makes the visit more fun and enjoyable. • Creates an available post-visit experience	• Inadequate amount of instructions • Lack of motivation to visit the webpage • Technical difficulties lead to user confusion • Problems with users being unable to remember the web address

Table 3: Benefits and Drawbacks of the Save System

The Save System is in need of improvements to advance its effectiveness. Seeing as only 5% of users accessed their webpage, the system's goal was not being accomplished. This demonstrates that just because users created their page doesn't mean they will actually visit it.

2.3.2 Case Study of Low-Tech Trace

Victoria & Albert Museum: Mini-Saga: The Mini-Saga trace in the Best of British Gallery at the Victoria and Albert Museum is an example of a successful low-tech trace (Figure 8). *A Man Grasping the Hind Legs of a Stag* painting is displayed in front of a table with stools, writing paper, pencils, a folder of responses, and a box to place new responses in. A sign on the box urges visitors to write a short story on what they think is happening in the picture. The picture serves as an imaginative prompt for the stories. However, through the development process the wording on the box proved to be a key element of the trace's success. Before the label gave an indication of approximate length of the trace, only 5 responses were collected over 7 days. After the label was changed to indicate a story of up to 50 words, there were 23 responses over 25 days (V& A, 1999). Final observations gave the trace a response rate of 26%, of which the most common story was a fable, which revolved around the man pleading for his life.

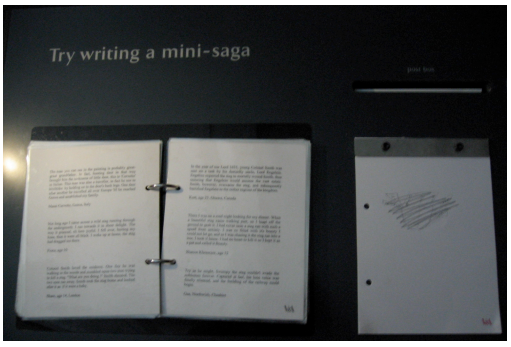


Figure 8: Mini-Saga Trace at Victoria & Albert Museum

Chapter 3: Methodology

The team worked from January 9, 2006 until March 28, 2006 to develop recommendations for trace in the new Launch Pad at the London Science Museum and general guidelines for implementing trace. Initial trace ideas were developed in Worcester, Massachusetts, USA for the first 7 weeks. The team worked at the London Science Museum itself from March 13, 2006 to April 28, 2006. However, the chosen traces will not to be introduced until the new Launch Pad is completed in December 2007.

The overall course of action for producing trace was influenced by the work done in Worcester and the feedback received from the staff of the London Science Museum. The trace ideas that were proposed and accepted then went through a cyclic process that resulted in the data needed to produce the end results. The following flow chart outlines the process that was followed to complete the designated goals:

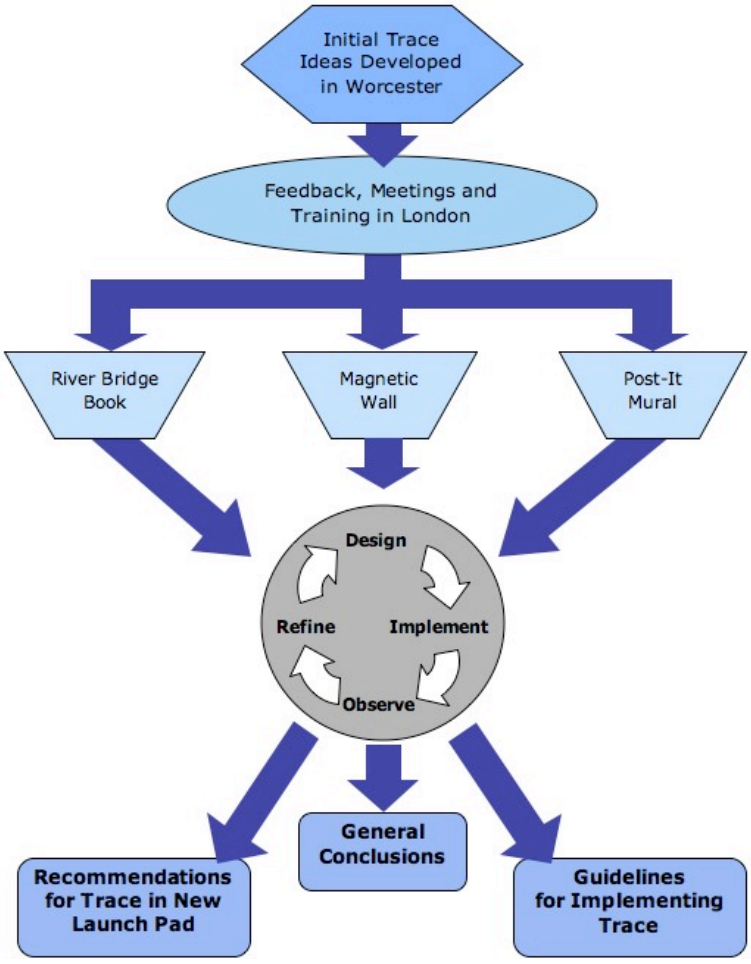


Figure 9: Methodology Flowchart

The breakdown of how much time was spent on each step of the process during the team's time at the London Science Museum can be seen in Figure 10 below. This timeline was continuously updated and altered to better suit the demands of the project. The timeline was also a tool that allowed the team to easily arrange to conduct interviews and observations at times that did not conflict with the rest of the visitor research staff.

<table>
<tr><th colspan="7">Dates of Prototype Implementation</th></tr>
<tr><td></td><td>Mon</td><td>Tues</td><td>Wed</td><td>Thurs</td><td>Fri</td><td>Weekend</td></tr>
<tr><td>Wk 1 13th -19th</td><td></td><td></td><td></td><td colspan="2">Training</td><td></td></tr>
<tr><td>Wk 2 20th -26th</td><td></td><td></td><td></td><td></td><td></td><td>River Bridge</td></tr>
<tr><td>Wk 3 27th -2nd KS2</td><td colspan="3">River Bridge: Cycle 1</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Wk 4
3rd – 9th
School Break</td><td rowspan="2"></td><td colspan="2">River Bridge: Cycle 2 (with book)</td><td colspan="2">River Bridge: Cycle 2 (without book)</td><td></td></tr>
<tr><td></td><td>Magnetic Wall at Plasma Ball: Q1</td><td>Magnetic Wall at Plasma Ball: Q2</td><td>Post-It Mural</td><td></td></tr>
<tr><td rowspan="2">Wk 5 10th -16th
School Break</td><td>Post-It Mural</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Magnetic Wall at plasma ball: Q2</td></tr>
<tr><td rowspan="2">Wk 6
17th – 23rd
School Break</td><td rowspan="2"></td><td>Post-It Mural</td><td>Post-It Mural</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Magnetic Wall at Shadow Box</td><td>Magnetic Wall at Shadow Box</td></tr>
<tr><td>Wk 7 24th -26th</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Figure 10: Prototype Implementation Timetable

3.1 Initial Trace Ideas

The team first began work on the project on January 9th, 2006. This was about 6 weeks before actually arriving on site at the London Science Museum on March 13th, 2006. Initially the group did background research on trace, focusing on learning through interactivity and traces currently being implemented. The preliminary trace ideas were based off of this background research. The traces were "Launch your Drawing into Orbit", "Scientist Lab Notebook", "Be a Scientist", and "Creative Building Workspace".

The Launch Your Drawing into Orbit trace idea involved getting Launch Pad visitors to draw a picture that represents and shows some part of their visit that was memorable. The goal of the trace was to get visitors to reflect on their experience in the gallery, to inspire creativity, and encourage socialization between participants. See Appendix B to view a rough sketch of this trace. The Scientist Lab Notebook trace was a notebook designed to aid the level of learning obtained from the entire Launch Pad gallery by setting up each exhibit as a goal to experience. The goal of this trace was to encourage visitors to experience the learning from the gallery to its fullest potential.

The Be a Scientist trace could be used in conjunction with the Scientist Lab Notebook trace or as its own independent trace. This trace involved having visitors' pictures taken while dressed up as a scientist. This was to get visitors in the mindset of thinking and making discoveries, just like a scientist. See Appendix B for a rough sketch of what the pictures may look like. Creative Building Workspace's goal was to have visitors convey their thoughts through building physical objects. This trace is a community builder; the shape the structure may take is influenced by all the visitors that use it. The detailed outline for this trace can be seen in Appendix B.

It was decided that guidelines for implementing trace in Launch Pad and a list of trace recommendations for the new Launch Pad was a necessary end result of the project. A table was developed that summarizes the group's initial trace criteria and illustrates the questions that will be used in evaluating potential traces and can be seen in Appendix C. Traces were to be evaluated through interviews, observations, and examining the trace each visitor made.

3.2 Trace Prototypes

The team arrived on site at the London Science Museum on March 13th, 2006. Being on site allowed the team to fully experience and understand the Launch Pad gallery, the background material found on Launch Pad was not up to date or sufficient enough for the team to understand exactly how Launch Pad functions. With this new information in hand, as well as the training sessions taught by the museum, the proposed trace prototypes to test in Launch Pad were redeveloped.

The team had originally viewed trace as something that could be taken home as well as left behind, however upon arrival trace was clarified as something that the visitor must leave behind. When a visitor takes home a creation that is considered an echo, which is a completely separate interactive concept from trace. The Scientist Lab Notebook therefore had to be eliminated because the team had designed the notebook so that a visitor may take home it home after their experience to remind themselves of what they had learned. The Be a Scientist idea was eliminated due to the expense of taking the photos, gaining parental consent for all visitors under 17, and the high level of facilitation it would require. However, more importantly was that the Science Museum did not want to create a stereotype of what a scientist should be like in the minds of the visitors, in fact that is the very thing the museum wishes to work against.

After viewing Launch Pad it became clear that the Launch Your Drawing into Orbit setup that had originally been proposed could not happen. One of the reasons was due to a severe lack of space in the gallery for an area large enough to have a table workstation. The gallery itself also strives to have activities that a visitor would not casually accomplish at home, such as drawing. Creative Building Workspace was eliminated first and foremost due to the expense of purchasing the magnetic building materials that can then easily be lost or stolen, it was also eliminated due to the limited amount of space in Launch Pad.

Training sessions were conducted on March 16th and 17th for a total of eight hours and covered everything from the subtleties of proper labeling to the ideal data analysis methods. This was done so that the team collected, analyzed, and presented data in the way that the museum expects from its full time visitor research employees. Some of the key points in development of trace and visitor research are:

- To understand labeling significance for physical context, maintain a visitor mentality for personal context, and allow for group interaction for socio-cultural context

- To implement trace and collect data in a systematic manner so the results are consistent and thus valid. All behaviors and responses that the visitors portray should have a corresponding code so that their reaction may be easily analyzed.
- To keep in mind the target audience, and whether or not the trace fulfills the designated learning outcomes, otherwise it is easy to lose sight of what needs to be achieved.
- To only concentrate on the randomly selected visitor's responses during an interview while maintaining a neutral tone and kneeling to the eye level of the interviewer, if needed.

3.2.1 River Bridge Book

The first trace implemented was decided to be a catalogue trace. The basis of a catalogue trace is that visitors leave behind their trace responses, these are then added to a collection of traces from the other visitors. These traces are kept on display to the public; usually catalogue trace is implemented in a way where it can be displayed in a bound notebook form. The trace would have the Dimensions of being exhibit oriented and facilitated.

The intended learning goals for catalogue trace are to lengthen the time in which a visitor interacts with an exhibit, show that there can be more than one solution to a problem, make the experience more memorable, and inspire curiosity about the topic at hand. The catalogue would show how other visitors interacted and reacted to an exhibit, as a result the visitor using the catalogue would be more inclined to achieve more than one solution. In showing a few of the various solutions, the trace eliminates the common mindset that there is only one solution to a problem and thus inspires creative new solutions from visitors outside of those in the catalogue. The visitor is taught to think outside of the box. By going through the catalogue and the various responses it is hoped that the trace may help to inspire greater curiosity in the exhibit topic and provide incentive for the visitor to learn more about the subject on their own. The catalogue trace strengthens the experience and learning accomplished in the mind of the visitor. Achieving this higher level of memorability makes it easier for visitors to access the concepts learned with greater ease at a later point.

Since the type of trace and its associated learning goals were established, the exhibit that best embodied the goals for the catalogue trace had to be determined based on these factors. The

exhibit candidates for the catalogue trace were River Bridge, Shadow Box, Hangover Problem, and Leaning Tower. For Shadow Box the group considered making a catalogue of pictures of the various shadows that visitors have made. After analyzing Shadow Box as a catalogue candidate it was eliminated due to the fact that creating a catalogue of various shadow positions would do little to enhance the actual learning achieved at Shadow Box. The group also did not possess the necessary materials to be able to capture and catalogue the shadows in a way that could be easily referenced.

Leaning Tower and Hangover Problem had few available solutions to create a catalogue from. Availability of the number of solutions is very important for a catalogue trace; this is so the amount of entries may be maximized without actually displaying all of the known solutions. River Bridge was a very tactile and visual exhibit; these two qualities make it particularly compatible with a catalogue trace. River Bridge was chosen because of this availability and flexibility in its solutions, in addition the museum also expressed specific interest in implementing a trace to improve the River Bridge experience.

The presence of the catalogue was intended to alter the way a visitor approaches River Bridge and to improve the learning outcomes. The cognitive learning outcome is to raise an understanding of how objects balance about the centre of gravity. Counterbalancing is an effective way to make supports off the centre of gravity so the structure may span longer distances. It is also to raise an understanding of how bridges specifically incorporate this concept into their structures. The affective learning outcome is to create curiosity about the science behind counterbalance. The skills learning outcome is to develop the ability to see alternate solutions to problems. It also will help with determining through experimentation the science behind counterbalances. The social learning outcome is to develop the ability to discuss problems with others and to work with them to arrive at a solution.

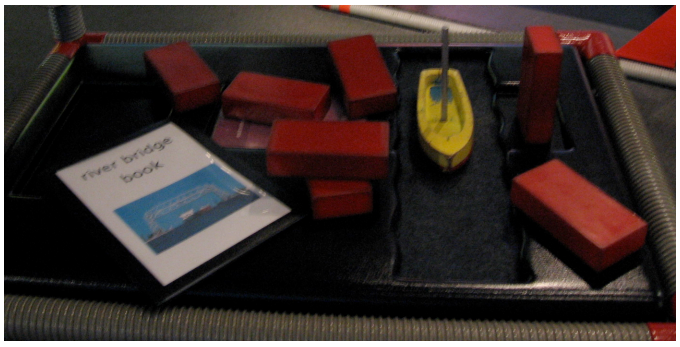


Figure 11: River Bridge Book at Exhibit

The prototype of the River Bridge Book (as seen in Figure 11) was created from bridge examples that the group recorded, rather than going through the process of collecting actual visitors' solutions. For the sake of this

implementation, the group created the catalogue and observed the users' ability to benefit from the catalogue's presence and their willingness to contribute their own images and comments. A major reason behind this approach is because the project group did not have the resources to fully implement a catalogue system that involves taking digital images that are then displayed for others to see.

There were a total of twenty pictures in the book, which were separated into two parts: hints and solutions. Pictures of hints that led to the final solution as well as pictures of final solutions were taken and placed in the book. The "visitor" comments about their creations were captured and posted with the pictures. The pictures in the book started with easy hints and became progressively harder, ending with two complex bridge designs. Appendix D contains a full copy of the final River Bridge Book.

Cycle 1

The ability of the River Bridge Book to achieve its learning outcomes was tested by observing and interviewing visitors who used the exhibit during "with trace" and "without trace" periods. This way the group could fully understand how the presence of the book changed the way visitors interact with the exhibit. Specific details that were noted while observing River Bridge were the number of structures built, the type of structures, and whether or not the visitor being observed was indirectly influenced by the book through the aid of someone who had already read it. The data sheet used for initial observations was the standard museum observation sheet and can be seen in Appendix E.

For the interview, the first set of interview questions (#1-6) evaluated the visitor's impressions of the exhibit itself whereas the second set of questions (#7-17) gathered data on their impressions on only the book. In addition to gathering data on the chosen interviewee the third question set (#19-21) addressed their parents/guardians. If the parents/guardians were present at the time the child interacted with the exhibit, the interviewer would request a mini interview with them as well. The questions that were directed toward the parents were just to get their brief impression of the book. The original interview format may be seen in Appendix F. This was how the entire first cycle of implementation was conducted.

The exhibit was observed with trace on the 25th, 27th and 28th of March for a total of 4.5 hours and without trace on the 28th and 29th of March for a total of 2.5 hours, see the timeline in

Figure 10. Based on the results of the first cycle appropriate changes were made to the trace and our means of data collection for the second cycle.

Cycle 2

The original observation method allowed for many inconsistencies, so a custom observation sheet was developed which prompts the observer to make sure to always record certain data (such as gender and age approximation) along with a coding system to make certain visitor behaviors easier to record and later analyze. The coding system included a categorization system of the structures that defined them as either "successful" or "unsuccessful", for further details on the categorical system used refer to the Results section. See Appendix G for the observation sheet and coding system.

In the second cycle the interview questions were shortened by extracting questions that were not significant to the desired data from the first question set. An important addition to the interviewing process was the addition of the question "If we were adding to the book, would you want a picture of a bridge you made in it?" This question provided the group with the proper data in order to evaluate visitor desire to actually participate in leaving a trace. More prompts were added to questions to make the interview questions easier for the interviewees to understand. See Appendix H for the updated interview sheet.

The group also made modifications to the River Bridge Book itself by including "hints" and "spoiler" warning sheets so visitors do not accidentally stumble upon a solution that another visitor developed. The River Bridge exhibit itself was moved to a spot closer to the entrance of Launch Pad because it allowed for easier observations without obstructed views, and for the observer to hear the visitor's conversations while using the exhibit. The River Bridge and Hangover Problem exhibits were switched, see Figure 4 for a map of where the River Bridge was moved to. The exhibit was observed with trace on the 4th and 5th of April for a total of 4 hours and without trace on the 6th and 10th of April for a total of 3.5 hours, see the timeline in Figure 10. These results were then compiled and analyzed and can be viewed in the Results section of the paper.

3.2.2 Magnetic Wall

The second trace we designed was a discussion trace for visitors to leave responses to thought provoking questions. These responses were then kept on display for the viewing of others. For our implementation purposes the comments were written on note cards and posted for others to see on a magnetic wall. The trace would have the dimensions of being exhibit oriented and unfacilitated, although it would need to be looked after to remove any posted graffiti.

The intended learning goals of the trace were to make the exhibit more than just a short engagement experience, inspire creativity, enhance communication skills, evaluate the level of exhibit subject comprehension, and inspire curiosity about the topic at hand. The nature of short engagement exhibits sometimes makes it difficult for visitors to fully absorb the learning behind the experience. In asking a question that indirectly asks the visitors what they have learned, the level of exhibit comprehension for the exhibit may be evaluated without directly putting visitors on the spot to report what they have learned to an expectant interviewer. It also gets people to reflect about what their experience meant, in terms of learning concepts.

The act of answering the question lengthens the engagement time spent at the exhibit, since it is an additional activity after visitors have used the exhibit. It may also lengthen the time spent at the exhibit by inspiring visitors to go back to the exhibit to figure out an answer to the question. In displaying the responses of others, visitors were inspired to write their own unique response that would stand out. Since the visitor's comment is posted for the public it should be written in a way that is understandable, this encourages the visitor to write legibly and in full sentences (if they used sentences in their response).

The exhibit candidates for the Magnetic Wall trace were Grain Pit, Energy Store, Shadow Box, and Plasma Ball. The Grain Pit exhibit had a lot of potential for open-ended questions that would inspire creative responses. However, due to the hectic nature of the exhibit it was advisable to not implement this particular trace for the exhibit. The exhibit itself also naturally attracts children at key stages 2 (ages 8-10) and under, and the group had to keep in mind that the new Launch Pad will place particular emphasis on key stage 3 (ages 11-14). Energy Store was eliminated due to the fact that questions directly regarding the activity of the exhibit had a limited number of straightforward responses. The Magnetic Wall was implemented on both Plasma Ball and Shadow Box due to the fact that they are short engagement exhibits, the

learning material behind these exhibits is sometimes not fully understood by visitors, and they have potential for many creative responses.

The presence of the Magnetic Wall was intended to alter the way a visitor reflects on their exhibit experience and to improve the learning outcomes. The cognitive learning outcome is to raise an understanding of the material that each individual exhibit tries to teach the visitors. In the case of Shadow Box the exhibit demonstrates that light travels in straight lines and that whenever these rays are blocked a shadow will be formed. Plasma Ball demonstrates that electricity will follow the path of least resistance, if the ball is touched by a person, the path of least resistance would be across the visitor's skin to the ground. The affective learning outcome is to create curiosity about the science of each exhibit. The skills learning outcome is to improve a person's ability to logically and/or creatively arrive at a solution to a given problem. The social learning outcome is to develop written communication skills.

Although the group had chosen its exhibits for Magnetic Wall, there were placement issues due to the lack of wall space around the exhibits. Proximity of the Magnetic Wall to its associated exhibit was essential for success. The solution was to take apart the Big Optics exhibit in order to utilize its stand-alone frame, and the magnifying lens was replaced with a magnetic board. Not only did this allow for the wall to be easily moved between exhibits but it also looked like it was a permanent aspect of the gallery. By using another exhibit for the frame the team attained an appearance of professionalism that otherwise would not have been accomplished due to project constraints. The museum's maintenance staff handled the process of dismantling and rebuilding the Big Optics exhibit, so that it was safe to put on gallery. Visitors wrote their responses on coloured index cards that were secured on the board with standard refrigerator magnets. The final product can be seen in Figure 12.

Figure 12: Magnetic Wall Trace

Plasma Ball

As discussed earlier, the first round of Magnetic Wall testing was done using the Plasma Ball exhibit. The Magnetic Wall was placed very close to the exhibit; the two were actually

touching. The first question, "What do you think is inside the Plasma Ball?" was posted on the Magnetic Wall as well as on the exhibit sign. After testing for Question 1 was completed, Question 2, "How do you think the Plasma Ball works?" was posted in the same fashion. The signs use to instruct the visitor may be seen in Appendix I. Question 1 was on gallery on the 5th of April for three hours, and Question 2 was on gallery on the 6th and 10th of April for a total of three hours. Both questions were on gallery for the same amount of time so that proper comparisons could be made.

Observations of Magnetic Wall were conducted for one hour while Question 1 was on gallery. The observer took special care to record if the visitor read other comments, the type of comment recorded, and if the visitor participated in a discussion while answering the question, see the timeline in Figure 10. The same observation sheet developed for the River Bridge Book was used with the categories of "looked at ball", "read comments" and "type of comment left" added. This may be seen in Appendix J. Periodically it was checked for graffiti and space was made available for more comments to be posted. Interviews were not developed for the Magnetic Wall simply because observations and examining creations gave sufficient information for analysis.

Shadow Box

The second round of testing for Magnetic Wall was done using the Shadow Box exhibit. Due to the close proximity of Plasma Ball and Shadow Box the Magnetic Wall was used in the same spot for both exhibits, the only difference was that that the opposite side of Magnetic Wall was used for Shadow Box. The Magnetic Wall was placed opposite the Shadow Box and was close within sight of the visitor both entering and exiting the exhibit.

Testing with Shadow Box, the prompt "Draw a picture of the shadow you made!" was posted followed by a follow up question of "Why do you think your shadow stayed on the wall?" This sign was placed on both the sign of the Shadow Box exhibit and on the Magnetic Wall itself, see Appendix K to view the sign used. Emphasis was placed more on the act of drawing a picture of the visitor's interactive experience than answering the question because this trace question was intended to provoke the creativity of the visitors. Whereas the other questions from Plasma Ball placed more emphasis on the visitor's understanding of the science behind Plasma Ball. Shadow Box was tested on the 18th and 19th of April for a total of six hours, see the timeline

in Figure 10. Periodically it was checked for graffiti and space was made available for more comments to be posted. Due to time constraints official observation periods were not conducted.

3.2.3 Post-It Mural

The third trace implemented was decided to be a personalization community builder trace. The basis of this trace is that visitors leave behind their personal responses, which are typically not based on concepts learned. This trace is a community builder because all of these responses collect until the goal of the trace is achieved, and it cannot be accomplished without the participation of many visitors. These traces are then displayed to the public. The trace would have the dimensions of being exhibit independent and unfacilitated, although it would need to be looked after to remove any posted graffiti just as with Magnetic Wall.

The intended learning goals of the trace were to inspire creativity, enhance communication skills, and create a sense of connection with the gallery and other visitors through the personalized response. The Post-It Mural inspired creativity by asking visitors an open ended personal question; these responses particularly embody the individuality of each visitor. A sense of connection is created with the gallery itself because the visitors have a way to personalize the gallery, to leave behind a sign that shows that they had been there. The trace sets up a goal with a definitive end (unlike with the other traces where visitor response may collect for as long as the museum chooses to implement the trace) that may only be achieved if visitors actively participate in the trace. This aspect is what makes the Post-It Mural a true community builder because the visitors must work together in achieving that goal. It also acts to inform other visitors which part of the gallery they most enjoyed and perhaps influence which exhibit visitors will visit.

The presence of the Post-It Mural was intended to alter the way a visitor reflects on their entire gallery visit and to learn more about other visitors. The cognitive learning outcome is to raise an understanding of all of the visitors that visit the gallery. The affective learning outcome is to increase their sense of connection with other visitors. The skills and social learning outcomes are to improve written communication skills.

The prototype of the Post-It Mural was made using a large poster board that a 156-box grid was drawn onto. Each grid box matched the size of a standard 76x76mm Post-It and had either a “Y” that indicated a yellow Post-It went there or an “O” that indicated that an orange

Post-It went there. The grid then formed a spiral pattern mural using the different coloured Post-Its. The visitor was instructed by the sign (as seen in Appendix L) to write their name, age, and favourite exhibit on their Post-It before placing it on the board.

The Post-It mural was mounted on the Hot and Cold exhibit (Figure 13). This way the board would not cause any damage to a wall through the mounting process. A large bench was then placed under the exhibit that acted to further support the board and as a hard surface for writing responses. The Post-It mural was placed in a high traffic spot (see Figure 4 for location map) across from the Help Desk and next to the Briefing Room. Observations occurred on the 7th and 10th of April for a total of 3 hours. The observation sheet was the same one used by Magnetic Wall and can be seen in Appendix J. The board was then put up on the 19th of April for 6 hours so that visitors could finish filling the mural in, see the timeline in Figure 10.

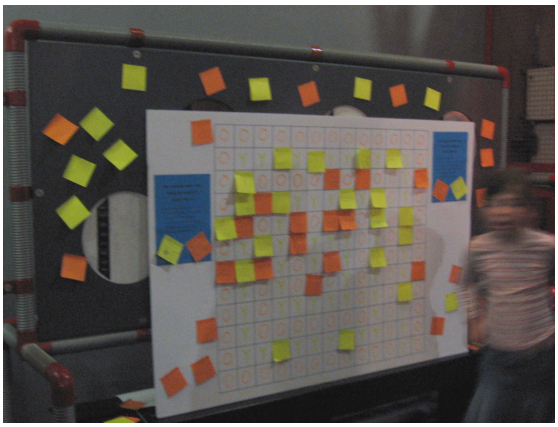


Figure 13: Post-It Mural on Hot and Cold Exhibit

3.3 Creating Guidelines for Implementation of Trace

Upon completion of the project, the team presented the London Science Museum with general guidelines to assist with planning, designing and implementing trace. The guide aims to provide assistance to museum staff who wish to understand what trace is, why it's important and the process to take in developing an effective trace. All important issues and considerations that we came across are discussed in the guide.

The guide is a summation of our process for developing trace. It establishes trace by discussing examples of trace from the trace compilation list and explains the dimensions trace can be divided into. After establishing a background for trace, we stated important issues to consider such as "How will the trace be maintained?" and "Will the trace be staffed?"

In our own development process, we came across three types of exhibits, 2 from Launch Pad and 1 from the general museum, which trace could be oriented with. The issues and benefits that we came across are presented for others to utilize. The last section of the guidelines outlines the design and implementation process. This process, based off our own, begins with establishing

the learning goals and ends with the assessment of the trace. At the end of the document, we referred the reader to this report for a more detailed explanation of the trace process.

3.4 Recommendations for Trace in the New Launch Pad

Upon completion of testing our prototypes, we had a greater knowledge of trace and the ways in which is can be used in a museum setting. Our testing of low-tech trace prototypes led to conclusions about many trace concepts and roles. We observed many behaviour alterations and came to some new interesting conclusions. In summation of our results and trace background research, we were able to make some recommendations for trace in the new Launch Pad.

Keeping in mind the goals and visions for the new gallery; we made some high-tech recommendations that used the same concepts as our low-tech prototypes. The technology presented represents new and innovative ways of embodying trace. The recommendations suggest that particular traces trace dimensions be associated with certain exhibit types. In some cases proposed exhibits were used to give a feel of what it would look like or how it would be incorporated. Issues to consider about each recommendation are explained to the best of our knowledge.

Chapter 4: Results and Analysis

The traces to be prototyped in the current Launch Pad were selected based on previous observations, background research and museum input. The appropriate interview and observation sheets were developed so that the data collection and evaluation of the traces could begin. When a trace was exhibit dependant, the exhibit was evaluated with and without the trace so improvements could be made to the trace. The implementation and assessment process was repeated for each trace multiple times and, on each cycle, a major aspect of the trace was changed to try and improve its ability to match the learning goals. The results of each trace cycle were compared so that the group could make the best possible suggestions for the implementation of trace in the new Launch Pad.

4.1 River Bridge Book

The group selected the River Bridge exhibit to investigate the effect of a catalogue-type trace. The objective of this exhibit is to use seven blocks to create a bridge that a toy boat may fit under (see Figure 14 to the right). A challenge is added to this exhibit through a series of markings that indicate difficulty levels of easy, hard, very hard and extremely hard. The two points that the bridge must rest on spread farther apart as the level of difficulty increases. The reason for selecting this exhibit was that it was one which a) allowed users to come up with many different solutions at each level of difficulty and b) users are encouraged to come up with different solutions through the presence of the challenge. In addition, it was felt that this exhibit was particularly appropriate to the 11-14 year old section of the target audience, which the future Launch Pad will place more emphasis on.

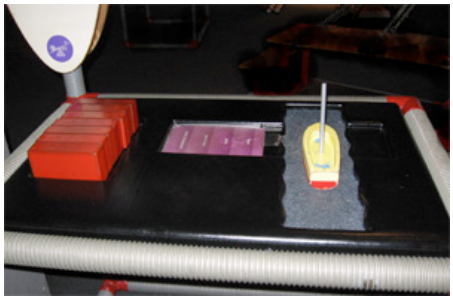


Figure 14: River Bridge Exhibit with Blocks in Storage Position

River Bridge was tested in two cycles: Cycle 1 was treated as an opportunity to pilot both the trace ideas and our initial methodology approaches. Cycle 2 was used as an opportunity to correct any flaws with the River Bridge Book that were made apparent through interview and observation feedback. Cycle 2 also refined any errors with the data collection system itself.

4.1.1 Cycle 1

In total, 72 observations and 20 interviews were made with the book on gallery, and 8 interviews were conducted without the book on gallery. The raw data for Cycle 1 can be seen in Appendix M. There was more "with trace" data than "without trace" data due to an unusual amount of Launch Pad school group cancellations during the "without trace" time period which greatly reduced the number of visitors in the gallery. Thus, major comparisons between the "with trace" and "without trace" groups were not made. Nevertheless, the data was sufficient to indicate shortcomings in our methods and appropriate changes to be made for the next round of implementation. These shortcomings are discussed later in this chapter.

Observations

For Cycle 1, 72 visitors were observed at River Bridge; 64% were children, and 36% were adults. For the initial observations, "adult" was classified as anyone who appeared to be age 20 or over. Based on our observations, there was an almost equal division of people who used the book and those who didn't (46% and 51%, the remaining 3% only looked at the book). 39% of children used the book as opposed to 58% of adults. Out of the visitors that used the book, 60% used it while they were building a bridge at the exhibit.

For the purpose of this evaluation we defined a "successful structure" as one that spans the "river" on the exhibit (a small patch of carpet). To do this, the visitor would need to use at least five blocks. Bridges that were not built over the river were not counted as a successful structure. For all visitors observed, the rate of success rose by 5% (from 19% to 24%) with the book on gallery. When comparing building a successful structure with and without the book, children were slightly more successful when using the book (20% compared to 17%). The difference was more noticeable for adults, where 31% were successful with the book and 23% successful without the book.

Interviews

Within the visitors interviewed, only 20% had said they did not interact with the book. However, at this point the team did not compare to the observations to see if they were indirectly influenced by someone who had used the book. Of the 20% that claimed to have not used the book, half stated that they did not see the book and thus did not have a chance to interact. Of the

visitors that interacted with the River Bridge exhibit, 40% said they knew what to do from reading the sign and 35% said they knew from using the book. This shows that the River Bridge Book is significantly complementing to the sign of the exhibit as an instructional/guiding tool.

Overall, visitors liked the book and particularly enjoyed the comments and hints left by other visitors and the accompanying photos. The majority of the visitors interviewed (69%) had nothing specific about the book that they disliked. The main points of dislike that were collected from the interviews were that 44% of the responses had asked for more instructions, hints and/or ideas to be put into the book whereas only 6% requested to have less data presented. A couple notable suggestions for improving the book were to mount the book on the sign (so that the book could not move out of the visitor's line of sight) and to divide the book into a hints and solutions section (the two would be divided by a "spoilers" warning page). One parent was particularly concerned that the visitors "should develop their own" bridges and the book could be used too easily for cheating. Another parent suggested that children should build their own bridges altogether without aid and another stated a wish for just simple structures to be shown. While another parent felt that even if a child uses the book only to copy the solutions, more factual knowledge was gained from the copying process than if they had attempted and given up on a bridge.

4.1.2 Cycle 2

The aim of this cycle was to implement the refined trace and methodology approaches based on the analysis conducted from Cycle 1. This analysis included improvements with the trace itself that the observations and interviews indicated, as well as improvements with the methods by which the data was collected.

A total of 38 interviews (19 with trace and 19 without) and 143 (71 with trace and 72 without trace) observations were made, 72% of which were in the target age range for Launch Pad of 8-14 years. Due to the beginning of school holiday, all data was collected on non-school days. There were still large groups that visited Launch Pad. However, this data was mainly obtained from family groups. Based on the data collected, four key areas were examined: length of engagement, basic success, successful structure and socialization.

Length of Engagement

Based on the total time each visitor spent at River Bridge with and without the book on gallery, a few comparisons can be made. The following tables document the levels of engagement achieved for visitors with and without the book on gallery. From the summative evaluation of Active Prolonged Engagement (APE) at the Exploratorium, we used their five categories of engagement to determine the data seen in Figure 15 (Tisdal, 2004). The following category definitions were used:

- "Minimal engagement": under 30 seconds
- "Slightly more engaged": 30 seconds to 1.5 minutes
- "Basic meaningful engagement": 1.5 minutes to 3 minutes
- "More meaningful engagement": 3 to 4 minutes
- "The best we could hope for": 4 minutes and up

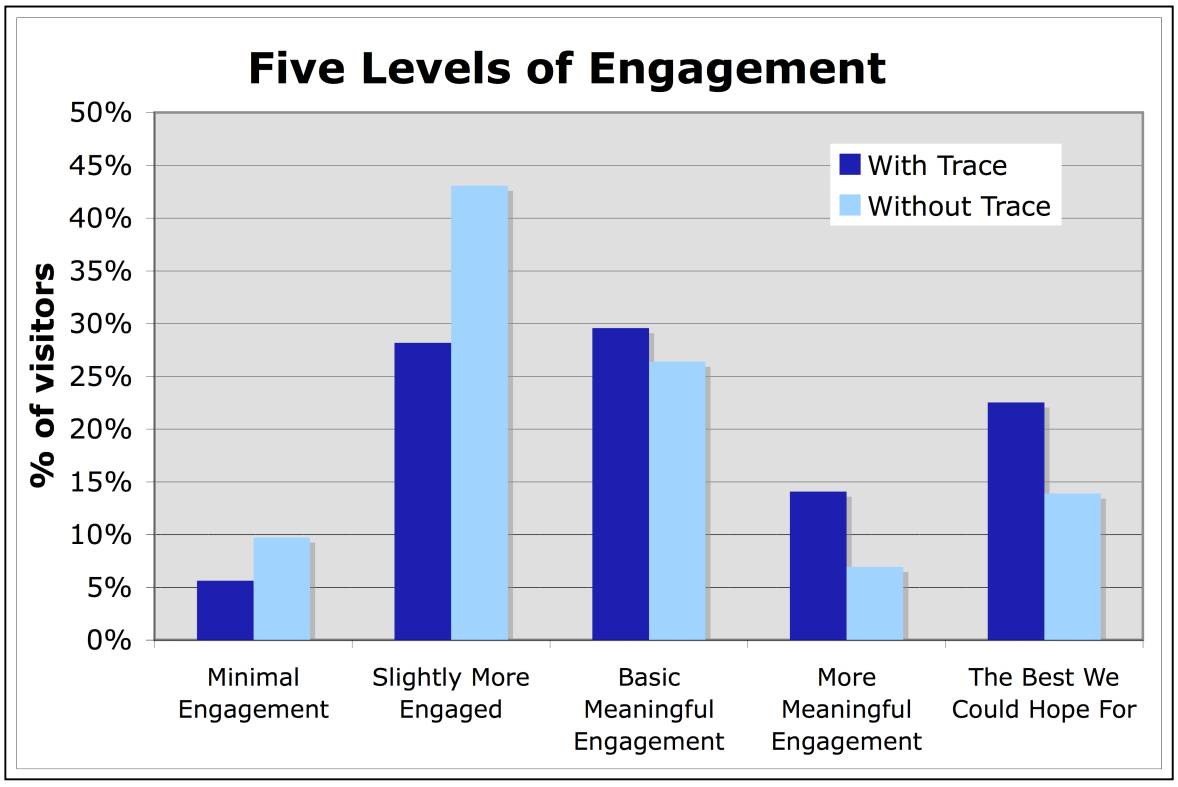


Figure 15: Five Levels of Engagement at River Bridge

For "minimal" and "slightly more" engagement categories, which are undesired levels of engagement in APE exhibits, the number of visitors decreased by 4% and 15% respectively. In

comparison, the number of visitors at the higher levels of desired engagement in APE exhibits were increased: “basic meaningful” (3% increase), “more meaningful”(8% increase) and “the best we could hope for”(10% increase).

Another chart was created to combine the five levels into three levels of low, medium and high engagement. Low engagement (undesired) was defined as 0 to 1.5 minutes, medium engagement 1.5 to 3 minutes, and high engagement (desired levels) was anything over 3 minutes. Figure 16 shows the level of engagement for visitors with and without the book. With the book on gallery, there was an increase in medium and high engagement. Using the data obtained from observations, we can conclude that this occurs because the book helps visitors in understanding what to do at the exhibit.

Trace increased visitors’ curiosity about the exhibit and the science concepts it incorporates. One of the interesting findings about the trace is that visitors were likely to stay for longer periods of time at the exhibit. Spending more time at an exhibit is believed to have a positive impact on learning because the longer you stay at an exhibit, the more you learn (Burch, 2006). By Calculating the average times spent at the exhibit of 44 visitors who used the book or looked at it and 44 visitors that did not use the book nor look at it, we found that with trace visitors spent an average time of 3:24 (mm:ss). Without the book visitors spent an average time of 1:47.

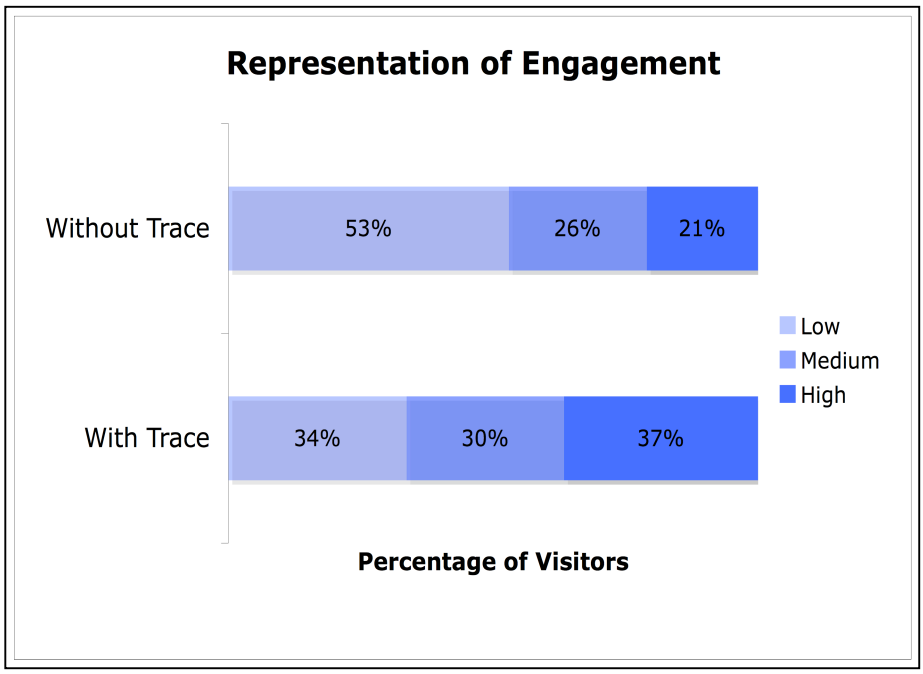


Figure 16: Representation of Engagement at River Bridge

Basic Success

At River Bridge, a successful experience was defined as when the visitor built a bridge to any of the levels of easy, hard, very hard, or extremely hard. There was a decrease in the number of visitors that did not have a successful experience after including the book. Without the book on gallery, 11% of all observed visitors did not have a successful experience. With the book on gallery, only 3% of the visitors observed did not have a successful experience. Basic success just defined building a basic structure within the context of the goals of the exhibit. It did not describe a deeper level of understanding of the central purpose of this exhibit. Therefore we needed to define a further level of success.

Successful Structure

A Successful Structure was defined as a structure connecting any two points, whether or not they are larger or smaller than the minimum difficulty success level for basic structure. This structure may not necessarily involve the counter balance forces required to span long distances that the exhibit strives to teach about. However, it demonstrated that the blocks could be arranged in a stable way if the blocks are properly positioned to support one another.

A 5-block structure can be seen in Figure 17(a). It is a bridge that spans the river to the level of "easy" and does not require the use of any counterbalance. A counterbalance is a weight placed on the end of a structure to cancel out the effect of an overhanging block. A picture if this can be seen in Figure 17(b). The next harder structure to build is the 7-block counterbalance bridge as seen in Figure 17(c). This bridge can reach the levels of "hard" or "very hard" depending on the orientation of the blocks. Placing the center block diagonally will extend the bridge slightly (Figure 17(d)). The level of "extremely hard" can be reached by creatively arranging the blocks. Two notable structures that were included in the book were the "Aztec" structure, named after the ancient civilization's style of building (Figure 17(e)) and the "A-frame" structure (Figure 17(f)).

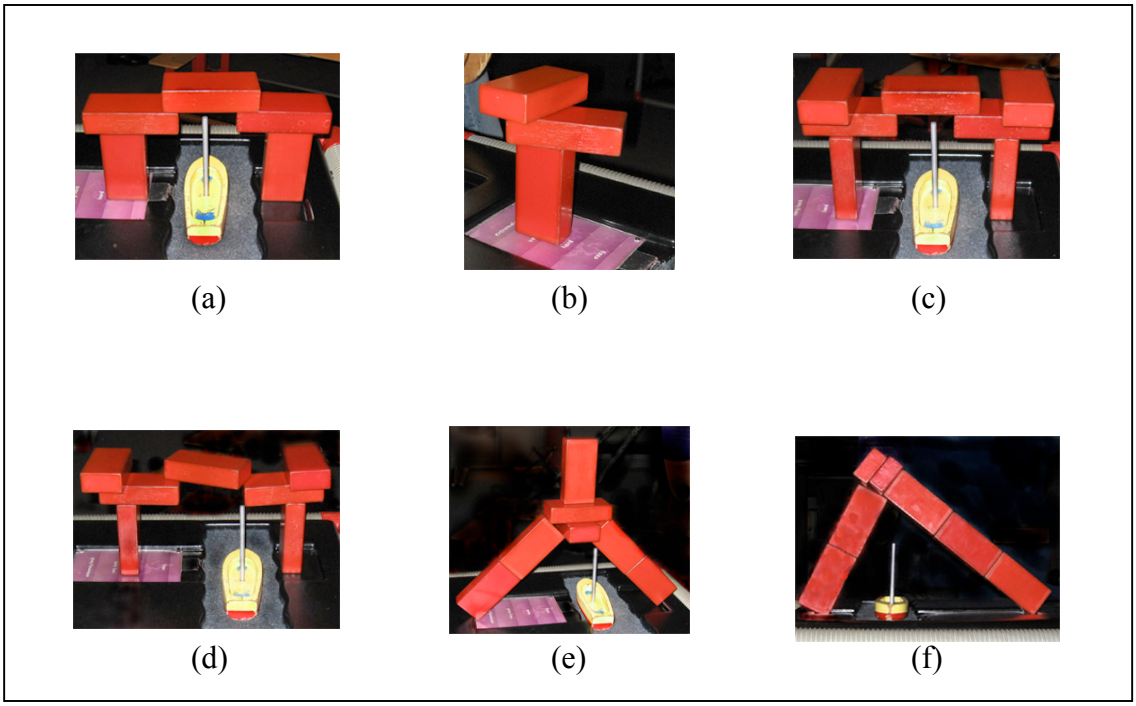


Figure 17: Types of Bridges for River Bridge Exhibit

Without the book on gallery, many visitors walked away satisfied after they built a simple 5-block structure (Figure 17(a)), and only 13% of visitors completed a 7-block counterbalanced structure (Figure 17(c)). This was considered somewhat of a problem considering counterbalance was the main focus of the exhibit. With the book, more visitors were able to create more difficult structures (42% built a 7-block counterbalanced bridge), and once they completed a simpler structure, they often attempted to build a more difficult structure (either one in the book or their own design). With the River Bridge Book, 55% of observed visitors were able to build a successful structure.

Having the book at the exhibit made it more challenging. The effect of the trace as an incentive for visitors to attempt and build a greater number of structures was measured. We found that only 14% observed without the book built more than one successful structure. While 24% of visitors who used the trace built more than one successful structure (10% increase) and generally had more attempts to build a successful structure. Only 1 visitor out of 73 observed without the book managed to build a 7-block extremely hard structure. While 6 out of 72 visitors that used the book were able to build that structure and then they went on and built other structures (new/different difficulty).

The book's effect on the level of difficulty that visitors achieved was also determined. Harder structures were defined as anything within 7-counter balance structure and 7-block extremely hard. Without the book, 13% of visitors built harder structures, while with the book, nearly half the visitors observed (49%) were able to build a harder structure.

Socialization

For all observations, it was noted if the visitor was alone or with a group. It was also noted if there were any bridge related discussions when in a group. "Bridge related discussions" are any discussions that visitors have that relate to building a bridge, such as "let's try putting the block like this" or "maybe if we do it this way we can get to extremely hard". While the percentage of bridge related discussions remained about the same with the addition of the book (43% compared to 46%), a difference in the depth of conversation was observed with the book on gallery. It appeared to prompt more in-depth conversations. For example, without the book on gallery, comments such as "there aren't enough blocks" were made, while with the book, comments such as "that one was easy, let's try a harder one" were made. These are consistent with most discussions that were observed, which show that the book helped to make the exhibit more intellectually challenging.

An interesting remark that we obtained from our observations (no quantitative data) is that in some family groups, parents used the book to scaffold their children's experience by going over the hints and solutions in the book without showing it to their children. This way they were able to instruct their children and provide them with clues, suggestions and ideas to build a successful bridge. Parents also tried to direct their children to build harder structures once they were done with the simple ones.

The information obtained in the interviews further revealed valuable data that could not be documented by simply using observations. From both the interviews and observations it was apparent that most visitors were aware of what River Bridge was trying to show, with or without the trace. When the River Bridge Book was available, the majority of users who said they used the book claimed that the book was how they knew what to do at the exhibit (see Figure 18). On its own, the interview data did not tell us much about the effect of the book on visitors' learning. However, in conjunction with the observation data, we found out that the majority of the people who used the book made more, different and/or more complex structures.

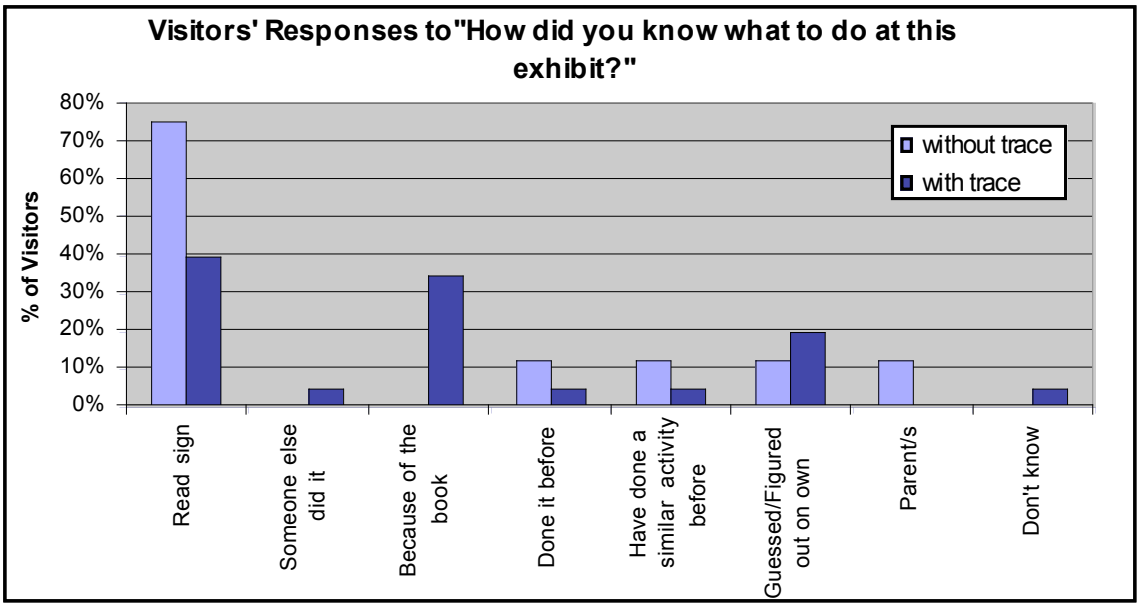


Figure 18: Visitor Responses to Interview Question

The visitors liked that the book showed the work of others (comments and hints) People liked that other visitors built the structures and that they had left their comments (personalization effect). They also liked that it gave ideas and solutions that helped them when they got stuck. A few visitors said that they would like to see more instructions and more ideas and solutions.

4.2 Magnetic Wall

In order to fully grasp the effects of the Magnetic Wall, it was tested on two different exhibits, the implementation plan for which was described in detail in Chapter 3. First, the Magnetic Wall was tested during school holiday using the Plasma Ball exhibit with two different questions. Next, the Magnetic Wall was tested on Shadow Box, also during school holiday.

4.2.1 Plasma Ball

Question 1: What do you think is inside the Plasma Ball?

The question and the cards were on gallery on the 5th of April for three hours, with observations occurring for one hour. A total of 31 observations were made during that time. The observation sheet used was one the museum currently uses, which can be seen in Appendix E. 74% of observed visitors left a comment. 70% of those visitors read what other visitors had written. Nearly half of all observed visitors were with a group and discussed the question and about 10% of all observed had called other visitors over to the Magnetic Wall.

A total of 105 comment cards were put out, and 87 responses were received. Responses varied from graffiti to complete sentences. By examining what comments visitors' had left, we created the following table that outlines the range of responses received:

Range of responses	# Of Responses	# Of Sentences	Tried to explain process
Electricity	38	12	2
Plasma	8	4	0
Static electricity	6	3	0
Light	5	2	0
Magic/fairy	5	0	0
Gas	2	0	0
Other	9	7	2
Graffiti	14	2	0
Totals:	87	30	4

Table 4: Range and Number of Responses from Question 1

For analyzing data, the categories of "other" and "graffiti" were explicitly defined. "Other" included one word responses such as: vacuum, water, gaseous matter, storm, chemicals, electricity mixed with cytoplasm, irony, and ball is nutty. *"Graffiti"* encompassed all responses that were irrelevant to the question that was asked.

The four responses that attempted to explain the process were:

- *"I think its electricity mixed with cytoplasm and in a glass container trying to find force."*
- *"The plasma ball contains gaseous matter which is converted into electricity via plasma."*
- *"I think the electric ball is like thunder that will burn your fingers off."*
- *"I think it is electricity being drawn to your hand so it uses a conductor to get to the ground."*

Based on the observations and results from testing Question 1, we altered our methods in order to better evaluate Magnetic Wall. These alterations were made to allow for more consistent observations and to minimize the time needed to write each observation. For the second cycle of testing, the question was changed to explore what types of responses would be received. It was hoped that by changing the wording of the question visitors would give more detailed responses.

Question 2: How do you think the Plasma Ball works?

Over the three hours that the question was on gallery, 33 responses were received. Table 5 below outlines the range of responses received from Question 2.

Range of responses	# Of Responses	# Of Sentences	Tried to explain process
Electricity	13	9	7
Static electricity	4	1	1
Warmth/Heat	4	0	0
Magic	1	1	0
Circuit	2	2	2
Solar system	1	1	0
Science geeks	2	2	1
Graffiti	6	0	0
Totals:	33	16	11

Table 5: Range and Number of Responses from Question 2

As with Question 1, some visitors did try to explain the process of how the Plasma Ball works. Some of their responses were:

- *"Electricity wants to get to earth as efficiently as possible, by putting your hand on the ball electricity is transferred through you and down to the earth."*
- *"The electric in the ball is trying to reach you to get into the ground."*
- *"Skin provides and easier escape route to complete the circuit."*
- *"Static electricity reacting on the warmth of the hand."*

Impact of Question: Comparison of Question 1 vs. Question 2

The number and quality of responses were indeed affected by changing the question. For the first question we received a larger number of responses, but most of them were one-word answers, such as "*electricity."* For the second question, we received about 1/3 the amount of responses from the first question, however there were many more multi-word answers. The phrasing of Question 2 is such that it requires a more detailed response. The number of sentence responses rose from 35% from Question 1 to 49% from Question 2. This supports the idea that Question 2 prompts for a more detailed response. Despite the changes in the number of

responses, the amount of "graffiti" remained consistent between the two questions (at about 17%).

The charts below (Figure 19) show how changing the question altered the type of response that was received. For Question 1 only 14% of those who wrote a sentence attempted to explain the process, while 69% of those who wrote a sentence for Question 2 attempted to explain the process.

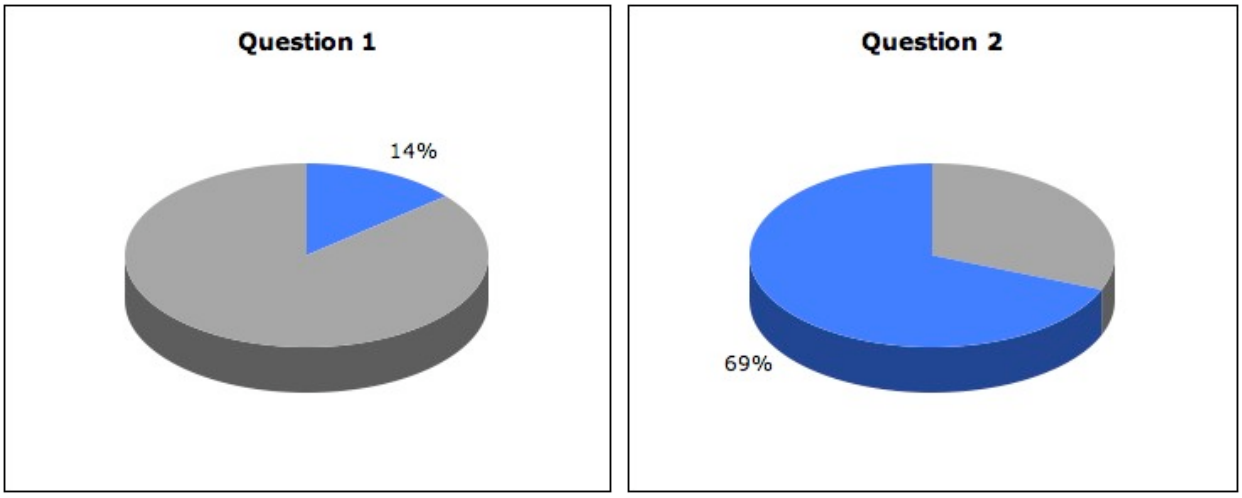


Figure 19: Comparison of number of visitors who attempted to explain the process with Question 1 and Question 2

4.2.1 Shadow Box

Prompt: Draw a picture of the shadow you made!

A total of 68 responses were received. There was a prompt on the instructions sheet that asked: "Why do you think your shadow stays at the wall?" Responses varied from graffiti to complete shadow drawings. By examining what comments visitors had left, we created the following (Table 6) that outlines the range of responses received:

Range of responses	# Of Responses	Percentage %
Shadow Drawings	33	49%
Offensive Drawings	8	12%
Other	12	17%
Graffiti	15	22%
Totals:	63	100%

Table 6: Range and Number of Responses from Shadow Box

For analyzing data, the category of "offensive drawing" was added to define rude or inappropriate drawings. Half of the responses were direct answers to the question asked; this was a sign of success in terms of staying within content. The amount of undesired responses was 34%, which is relatively low when compared to other feedback exhibits. According to Gammon's "The Power of the Pencil", on average there are 70% graffiti responses in feedback exhibits.

There was an increase in the amount of undesired responses, e.g. Graffiti and offensive drawings between testing with Shadow Box and Plasma Ball. Inappropriate responses made up 34% of the total responses comparing to 17% with Plasma Ball. The increase in inappropriate responses can be attributed to the type of prompt posted. It is much easier for a child to draw something inappropriate than it is to write something inappropriate.

4.3 Post-It Mural

The Post-It mural was a different type of trace compared to the River Bridge Book and the Magnetic Wall. Its main goal was to give visitors the chance to see who has been to Launch Pad before them, giving the gallery a more personalized feel. By leaving their name, age and favourite exhibit on a Post-It, the visitor contributes to the larger picture, which is made up of many individual Post-Its. A total number of 86 observations were made in which 64% of the people observed had used a Post-It. The rest were visitors that stopped to see the mural but did not leave a comment.

Due to the beginning of school holiday, all data was collected on non-school days. There were still large groups that visited Launch Pad, however, this data was mainly obtained from family groups. Based on the data collected, three key areas were examined: length of engagement, socialization, and favourite exhibit.

Length of Engagement

We calculated the average time spent at the trace based on the total time each visitor spent. From all of our observations the average time spent was approximately one minute. This trace element could be categorized under short engagement exhibits; these exhibits are further discussed in the following guidelines chapter.

Socialization

For all observations, it was noted if the visitor was alone or with a group. It was also noted if there were any related discussions. 58% of the visitors observed were in groups, mainly family groups, and 75% of these groups had discussions related to the mural. In some of the cases, parents helped their children with finding the name of their favourite exhibits and the spelling of some of the words. Some parents looked at the question and gave their children directions on what to write and where to place the post-it. Other parents urged their kids to fill out a Post-It after looking at what other people wrote. There were some cases where siblings helped each other leave a comment and other cases where kids called their friends over to show them what they had left.

Popular Exhibit

Out of the 55 people observed that used the mural, 53% wrote one word responses and 40% wrote sentences while only 7% left a graffiti comment. After the mural was completed, a total of 171 post-its were filled out by visitors to Launch Pad. Analyzing the responses showed that 21% of responses including a drawing. This number can be attributed to the wording of the sign, which stated, “you can even be creative and draw it too”. The following table outlines the responses and the number received from visitors:

Range of Responses	# Of responses	Percentage %
Bubbles/Bubble Show	30	18%
Shadow Box	23	14%
Launch Pad in general	21	12%
Arch Bridge	11	6%
Grain Pit	9	5%
Energy Store	9	5%
Turn Table	7	4%
Pump Jet/Helicopter	7	4%
Sound Dish	4	2%
Tipper Trucks	4	2%
Tip Toe Tester	3	2%
Electricity	3	2%
Two-Way Mirror	2	1%
Puzzles	2	1%
Shake Hands	2	1%
Plasma Ball	1	1%
Bucket Radio	1	1%
Lock and Key	1	1%
Graffiti	31	18%
Total:	171	100%

Table 7: Range and Number of Responses from Post-It Mural

For analyzing data, the "graffiti" category was explicitly defined. Graffiti included any responses that were not related to LP or to what the trace is asking for. That includes random drawings, "I was here" comments (name/age), scribbles, and one word random responses.

Conclusion to Results

In general testing showed that trace was a beneficial addition to the exhibits and the gallery as a whole. The scientific concepts of the exhibits were conveyed with greater ease when trace was present. Trace increased the time spent at exhibits and the visitors generally enjoyed participating in trace. Visitors especially loved the concept of personalization; they found it enjoyable to leave their mark on the gallery and at the same time enjoyed looking over the work of others. Trace also improved the quality of conversation that visitors had at the exhibits, conversations would be more motivational about completing the exhibit and trace. It also increased the length of engagement time and motivated creativity. The introduction of trace overall improved the quality of the visitors interactions with the exhibit.

Chapter 5: Guidelines

The Guidelines for Design and Implementation of Trace have been developed to assist with the development of trace for museum galleries. The guide is a summation of our own prototyping and testing process as well as important considerations and background information on trace. The guidelines provide essential guidance for the development of new trace and can be found as a stand-alone document at the end of this report.

Chapter 6: Recommendations of Trace for New Launch Pad

The recommendations document was developed specifically for the Launch Pad Redevelopment Project. The ideas presented were derived from our prototype testing, research into existing traces, visits to other museums, and knowledge of the current Launch Pad and the plans for new Launch Pad. The final document can be seen in the stand-alone document section of at the end of this report.

Epilogue

In addition to learning all about trace, we have come to realize we now know more about the museum atmosphere than we ever expected to learn. Museums and their staff really do have a difficult job of creating an exciting engaging but always educational experience for their visitors. There is a vast amount of research and planning that goes into creating a gallery and we can now appreciate this.

Our research has proved that trace is a fairly new tool that museums should utilize in achieving their goals. The concepts we tested proved that trace has various interesting and positive effect on visitors behaviours and learning, even with something as simple as a "Post-It". We hope that our guidelines and recommendations assist the London Science Museum and Launch Pad Redevelopment Team in implementing trace in their new galleries. We look forward to December 2007 and hearing about the new Launch Pad.

Appendix A: National Curriculum Standards

The National Curriculum consists of educational standards for the United Kingdom. For each subject the curriculum is broken down into categories based on Key Stages 1 thru 4. The following are the relevant standards for Key Stages 2 and 3 taken directly from the National Curriculum that will be use as a reference for creating trace in Launch Pad. Each statement outlines what the child should be taught.

Electricity and Magnetism

Key Stage 2:

- To construct circuits, incorporating a battery or power supply and a range of switches, to make electrical devices work [for example, buzzers, motors]
- How changing the number or type of components [for example, batteries, bulbs, wires] in a series circuit can make bulbs brighter or dimmer
- How to represent series circuits by drawings and conventional symbols, and how to construct series circuits on the basis of drawings and diagrams using conventional symbols.

Key Stage 3:

- How to design and construct series and parallel circuits, and how to measure current and voltage
- That the current in a series circuit depends on the number of cells and the number and nature of other components and that current is not 'used up' by components
- That energy is transferred from batteries and other sources to other components in electrical circuits
- About magnetic fields as regions of space where magnetic materials experience forces, and that like magnetic poles repel and unlike poles attract
- That a current in a coil produces a magnetic field pattern similar to that of a bar magnet
- How electromagnets are constructed and used in devices [for example, relays, lifting magnets].

Forces and Motion

Key Stage 2:

- About the forces of attraction and repulsion between magnets, and about the forces of attraction between magnets and magnetic materials

- That objects are pulled downwards because of the gravitational attraction between them and the Earth
- About friction, including air resistance, as a force that slows moving objects and may prevent objects from starting to move
- That when objects [for example, a spring, a table] are pushed or pulled, an opposing pull or push can be felt
- How to measure forces and identify the direction in which they act.

Key Stage 3:

- How to determine the speed of a moving object and to use the quantitative relationship between speed, distance and time
- That the weight of an object on Earth is the result of the gravitational attraction between its mass and that of the Earth
- That unbalanced forces change the speed or direction of movement of objects and that balanced forces produce no change in the movement of an object
- Ways in which frictional forces, including air resistance, affect motion [for example, streamlining cars, friction between tyre and road]
- That forces can cause objects to turn about a pivot
- The principle of moments and its application to situations involving one pivot
- The quantitative relationship between force, area and pressure and its application [for example, the use of skis and snowboards, the effect of sharp blades, hydraulic brakes].

Light and Sound

Key Stage 2:

- That light travels from a source
- That light cannot pass through some materials, and how this leads to the formation of shadows
- That light is reflected from surfaces [for example, mirrors, polished metals]
- That we see things only when light from them enters our eyes
- That sounds are made when objects [for example, strings on musical instruments] vibrate but that vibrations are not always directly visible
- How to change the pitch and loudness of sounds produced by some vibrating objects [for example, a drum skin, a plucked string]
- That vibrations from sound sources require a medium [for example, metal, wood, glass, air] through which to travel to the ear.

Key Stage 3:

- That light travels in a straight line at a finite speed in a uniform medium

- That non-luminous objects are seen because light scattered from them enters the eye
- How light is reflected at plane surfaces
- How light is refracted at the boundary between two different materials
- That white light can be dispersed to give a range of colours
- The effect of colour filters on white light and how coloured objects appear in white light and in other colours of light
- That sound causes the eardrum to vibrate and that different people have different audible ranges
- Some effects of loud sounds on the ear [for example, temporary deafness]
- That light can travel through a vacuum but sound cannot, and that light travels much faster than sound
- The relationship between the loudness of a sound and the amplitude of the vibration causing it
- The relationship between the pitch of a sound and the frequency of the vibration causing it.

The Earth and Beyond

Key Stage 2:

- That the Sun, Earth and Moon are approximately spherical
- How the position of the Sun appears to change during the day, and how shadows change as this happens
- How day and night are related to the spin of the Earth on its own axis
- That the Earth orbits the Sun once each year, and that the Moon takes approximately 28 days to orbit the Earth.

Key Stage 3:

- How the movement of the Earth causes the apparent daily and annual movement of the Sun and other stars
- The relative positions of the Earth, Sun and planets in the solar system
- About the movements of planets around the Sun and to relate these to gravitational forces
- That the Sun and other stars are light sources and that the planets and other bodies are seen by reflected light
- About the use of artificial satellites and probes to observe the Earth and to explore the solar system.

Energy Resources and Energy Transfer

Key Stage 3:

- About the variety of energy resources, including oil, gas, coal, biomass, food, wind, waves and batteries, and the distinction between renewable and non-renewable resources
- About the Sun as the ultimate source of most of the Earth's energy resources and to relate this to how coal, oil and gas are formed
- That electricity is generated by means of a variety of energy resources
- The distinction between temperature and heat, and that differences in temperature can lead to transfer of energy
- Ways in which energy can be usefully transferred and stored
- How energy is transferred by the movement of particles in conduction, convection and evaporation, and that energy is transferred directly by radiation
- That although energy is always conserved, it may be dissipated, reducing its availability as a resource.

These standards are taken directly from the National Curriculum website: www.nc.uk.net

Appendix B: Original Trace Ideas

Launch Your Drawing into Orbit:

This trace idea involves allowing Launch Pad visitors to draw a picture that represents and shows some part of their visit that was memorable. The goal of the trace is to get visitors thinking about what they have just experienced. This trace would encourage creativity and socialization between participants. The viewing of other visitors' creations would also create a sense of competition. This idea is open-ended and could be altered to attract key stages two and three.

The trace would involve setting up an area of Launch Pad that contains various creative writing utensils and paper. This could include crayons, markers, scissors, coloured paper, and stickers. The trace would also require a large area such as wall space, a corkboard, or magnetic board, for visitors to post their creations. Visitors will be asked to add their name to their artwork in order to increase personalization. This area would bring a very colourful and personalized aspect to Launch Pad.

Materials needed:

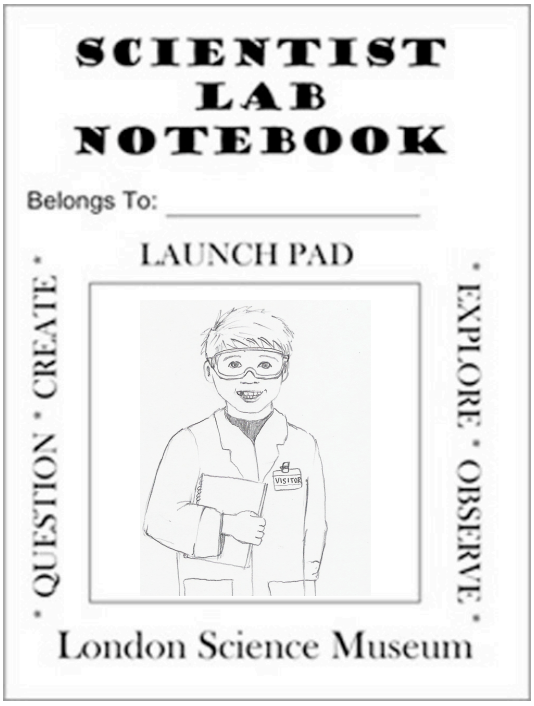
- Large table space with chairs
- Creative utensils (crayons, markers, stickers)
- Plain and colourful paper
- Wall space, cork board, or magnetic board
- Attractive signs and clear instructions

Specific Data to Collect:

- Number of traces completed (per day, user demographic, level of completion)
- Degree of creativity in traces
- Topics seen in traces
- Amount of supplies used per day
- Reasons why visitors did not create a drawing

Scientist Lab Notebook:

This trace element is intended to mimic a scientist's lab notebook. The notebook is designed as a tool to aid the level of learning obtained from exhibits in Launch Pad. One exhibit from each of Launch Pad's six scientific areas will be included in the notebook. It will include space for comments about exhibits, colour-in drawings, further explanations and questions about each exhibit. The material in the lab notebook should relate to the United Kingdom National Curriculum for key stages two and three in the area of science. It should be challenging while also being very interesting and exciting.



The lab notebook will be a trace element that can be utilized while in the gallery as well as after the visit. It also contains a place for a photograph of the visitor at some point in his or her Launch Pad visit. Another option that could be included in the notebook is a stamping incentive. Upon completion of exhibits, an ink stamp could be placed in each participant's notebook. This would help in creating a visual of what exhibits the user has interacted with, creating a passport resemblance.

This trace would be structured as well as open-ended. The lab notebook would have content that is focused on specific ideas and portions that allow for a wide range of creativity. Exact content of the notebook will be explored in detail once we are able to interact and examine each exhibit. The lab notebook will be a personalized memory of each visitor's Launch Pad experience.

Materials needed:

- Attractive advertisement and instructional signs to be placed on gallery
- Materials for printing notebook
- Digital or Polaroid camera
- Printing device

Specific data to collect:

- Number of visitors who used the lab notebook
- Degree in which notebooks were filled out upon exiting the LP through exit interviews

Preliminary List of Exhibits to be Included in the Lab Notebook

Scientific Concept:	*Specific Exhibit:*	*Key Points covered*:
Forces	Leaning Tower	Exploration • Centre of gravity
Materials	Slow Bubbles	Exploration • Up thrust and drag
Sound	Bucket Radio	Illustration • Sound vibrations and different mediums
Light	Kaleidoscope	Exploration • Reflections and light dissipation
Energy	Hot and Cold	Illustration • Heat conductivity of different materials
Electricity	Magnetic River	Illustration • Magnetic fields

Based on the three types of exhibits in Launch Pad (*Illustration*: one outcome, has to be done correctly, *Illustration and Problem Solving*: Illustrative but includes challenge, and *Exploration*: multi-outcome, user can affect variables), exploration exhibits were chosen when possible to adhere to a multi-outcome theme. This allows for participants to examine and question the different results in the lab notebook.

The lab scientist notebook can be expanded in many areas depending on its remedial evaluations. The specific exhibits included in the notebook are open to alteration as well as type of content related to each concept.

Be a Scientist:

The "Be a Scientist" idea is another trace that is aimed at allowing visitors to feel like actual scientists conducting research. "Be a Scientist" is designed to appeal to the target age group (ages 8-14) but could be expanded to include the wide range of visitors to Launch Pad. The trace appeals to individuals' desires to dress up. Lab coats and goggles will be provided to be worn in a Launch Pad photograph.

Materials needed:

- Digital or Polaroid camera
- Printing equipment
- Lab coats in various sizes
- Lab goggles
- Possibly other scientific props

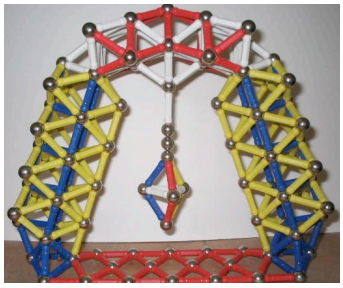
Specific data to collect:

- Number of pictures taken
- Enjoyment and excitement level of participants
- Problems in picture taking process

This trace is able to exist on its own but is designed primarily to provide the cover picture for the scientist lab notebook.

Creative Building Workspace:

This trace idea is an extension of current Launch Pad exhibits. The trace is not intended to convey a certain science concept but to allow visitors to convey their thoughts through physical objects. Visitors will be provided with LEGO® blocks, Magnetix® or other creative building materials and will be allowed to create objects that illustrate a thought or phenomena they learned from an exhibit. The creations will be left in an open exhibit area for other visitors to add more to if they wish.



LEGO® blocks and Magnetix® are fairly easy to operate but some starter ideas and instructions could be provided. Although providing ideas for the user would conflict with the goals of the trace, which are to provide a space for open creativity and collaboration. Visitors will be encouraged to work in groups by having a large collaborative workstation.

Materials needed:

- LEGO® blocks, Magnetix® or some type of building material set
- Space to set up building area
- Possible display space for outstanding creations

Specific data to collect:

- Types of creations made
- Number of times visitors built upon another's creation

Appendix C: Original Trace Design and Assessment Guidelines

Preliminary Design Criteria for Potential Trace to be Implemented in London

Expected Learning value: The expected learning value will be based on background knowledge of learning styles. This aspect will be rated based on how much the visitors can potentially learn from using the trace.	• Is the trace very hands-on and interactive? • Does it challenge previous knowledge of science concepts? • Is there one definite answer, or is it open-ended? • Does the trace require the user to form their own ideas?
Socialization: Social activity within the museum setting is vital in encouraging learning. We will examine to what extent the trace allows for collaboration between users.	• Does the trace allow for more than one operator? • Will additional operators hinder the intended outcome? • Does the trace support dialogue?
Ease of use: This value will be based on the expected operation accessibility of the trace element. This is also important in determining the range of users that will benefit from the trace experience.	• Is the trace focused at a certain age group? • Could it be potentially hard or confusing to operate? • Could this trace be adapted or made accessible to individuals with disabilities? • Does it have unclear feedback?
Fun Value: When targeting children ages 8-14, the fun aspect of a trace is essential to its success. They will be more likely to engage in and explore an activity that is enjoyable and exciting.	• Does the trace have exciting and inviting qualities? • Is the subject matter unappealing? • Is it something kids would really enjoy?
Ease of implementation: Ease of implementation examines the design and implementation process. We will estimate the resources and time required for successful implementation.	• How complex is the design? • What equipment is necessary? • How long will it take to implement? • What approval is necessary?

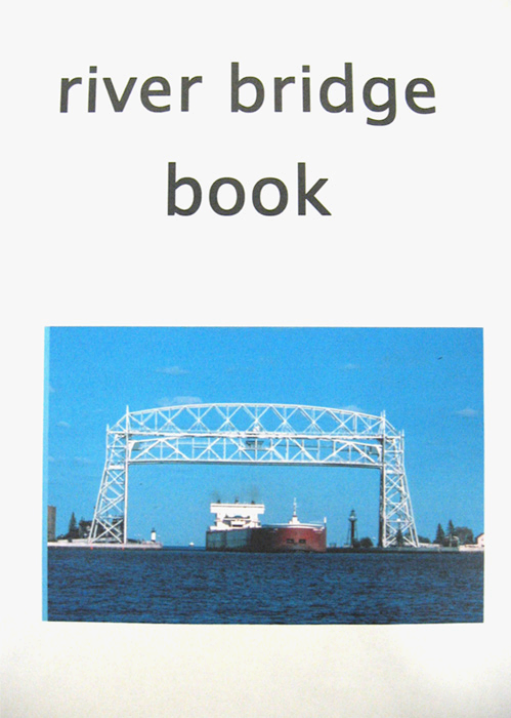
The following criteria will be used when assessing the successfulness of the implemented trace items. Each aspect will be rated on a low, medium, high scale. The developed ratings will

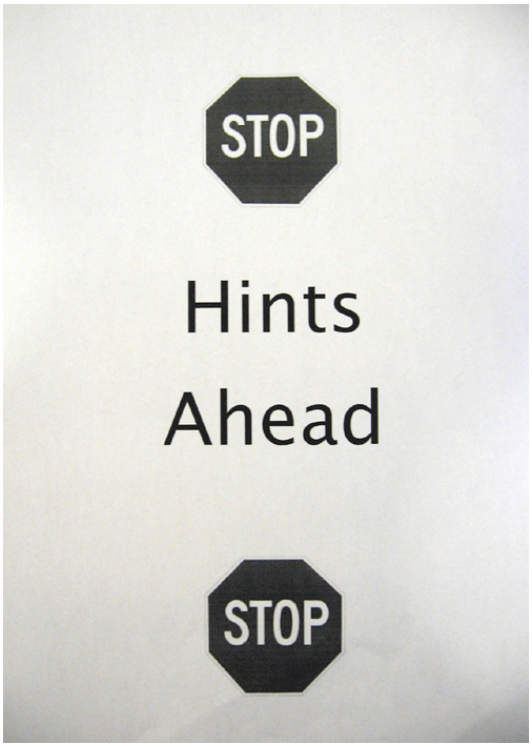
be essential in determining which trace elements can be implemented as is, which should undergo further alterations, and which ones hold no real value to the museum.

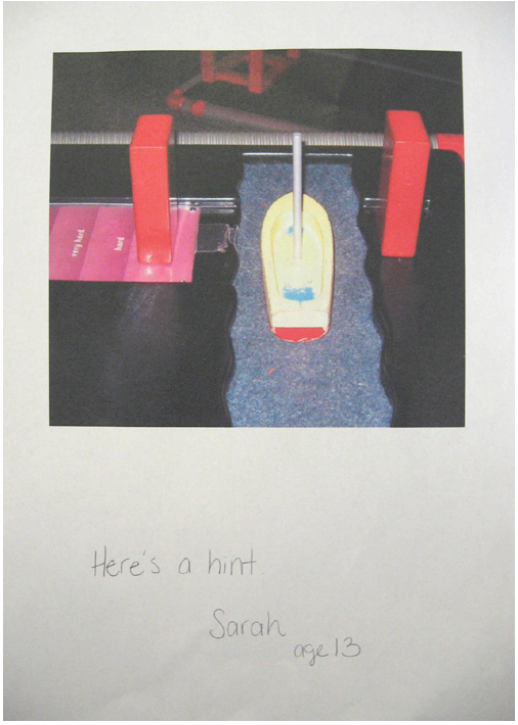
Assessment Criteria for Implemented Traces

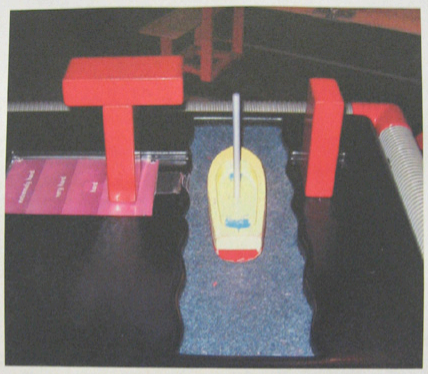
Usage of trace: A trace's success partially rests on its level of usage. It is hard to get valuable data without a good sample size. This value will be determined by counting the number of people who used the trace out of the number of visitors to the Launch Pad gallery. In order to determine usage, a baseline amount of time will be established. This aspect will also be broken down into partial participant, semi-participant and in-depth participant. Each allotted time frame will be trace-specific, as some trace elements will only require a shorter engagement time than others.
Likeability: This can be measured in two ways, by approaching visitors and asking them if they enjoyed the experience and by observing their use of the trace. When observing, we will watch for signs of excitement. An informal interview could be quickly conducted to get a relative idea of their opinion.
Learning Value: When evaluating the effects of the trace, we will determine whether the visitors' level of knowledge increased or was inspired in some way. There are various approaches that can be taken to obtain feedback from visitors. In our setting it is important to address the two types of visitors within the age range of 8-14, children on a school field trip and children with their parents. School field trips bring up the option of involving the teacher in the assessment. Teachers can be asked to have the students draw or write a representation of some aspect of their Launch Pad visit. These can then be sent back to the museum for a qualitative review. Family visitors are harder to assess. Options to address smaller groups of visitors include interviews and focus groups (surveys excluded for complexity and time constraints). It is possible to approach children with families as they leave the exhibit.
Usability: Usability will be determined by a combination of visitors' comments and by observation. Visitors can be asked about their troubles and dissatisfactions with the trace. By observing users interacting with the trace, we can look for signs of frustration or confusion based on body language. It is also important to note if it is within the capabilities of the targeted users.
Sociability level: Sociability will be measured based on observation. We will document the number of people who are engaging in the trace at one time, the level of conversation between users and the content of the conversation. It will also be important to state reasons why children looked isolated.

Appendix D: River Bridge Book

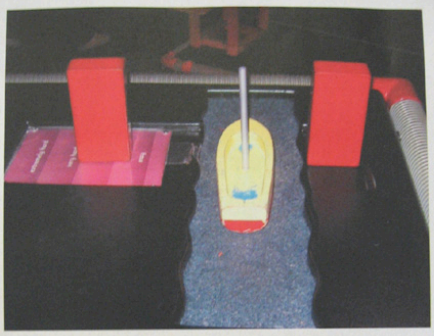








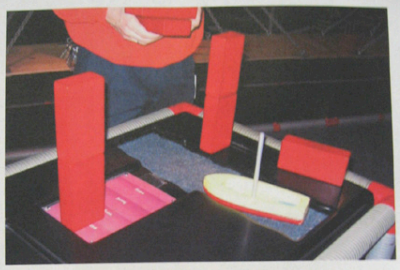
See if this helps.
Kevin age 9



easy hint .....
- Wayne, 11

Maybe this helps....
Look at where the top block is.
* Alexandra, age 14

I wanted to make my bridge tall
so I thought of angling the bricks.
Ryan, age 11

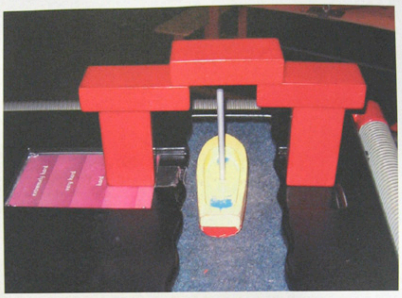


This is how I started.
Vanessa
age 11

STOP

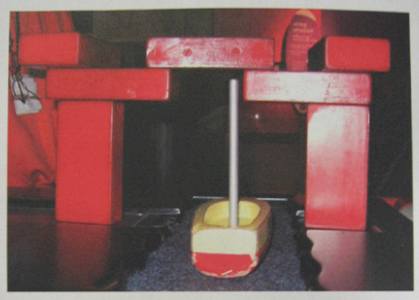
Possible
Solutions
Ahead

STOP

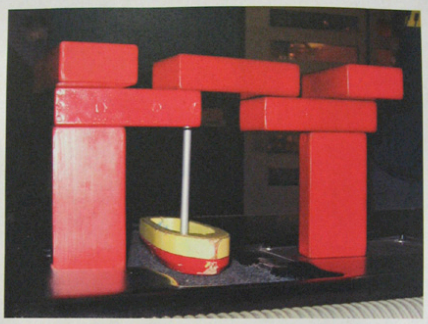


This is my pretty bridge.

Courtney, age 8

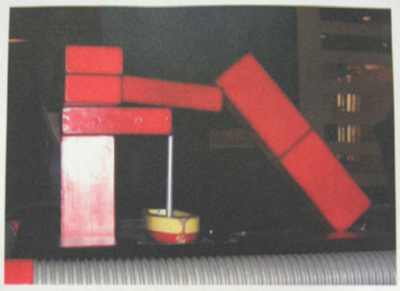


This bridge needed extra blocks on top or it fell down in the middle.
Samantha. Age 11



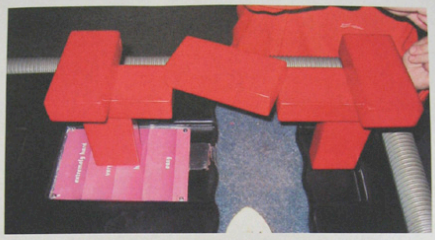
Here is what I made.

-Paul, age 10.



It fell down after but at least it stayed for the picture.

Emily age 12

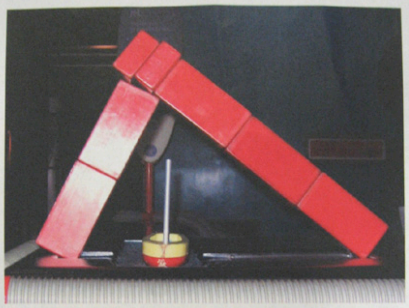


Think about the corners...

Isabella, age 12

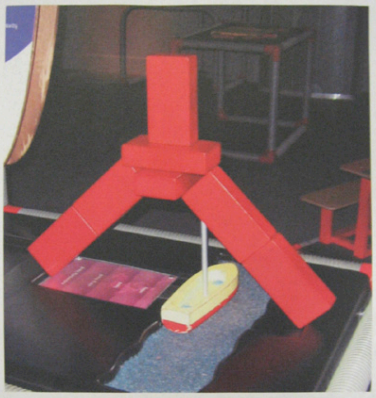
It almost stayed, I wished it had it would have been the best bridge.

Ashley Age 13



I got my bridge to go to extremely hard. My dad helped me build it, but I designed it all by myself.

Sean, age 13



It took me a while to figure this out and I challenge you to make it yourself!

Bob, 32

Appendix E: Museum Observation Sheet

Specific points to look out for.	Describe what they do step by step as if dictating it out loud. Write as much as you can.
User reactions? (Body language etc.) Before, during and after use? Do visitors stay to complete the task? Do they know what to do? How do they know what to do? When, if at all, are users reading the label (before, during, or after the activity) Do visitors use the exhibit together? What do they say to each other? What do visitors point out to each other? Does someone lead/take charge of the interaction? Who, and at what point? Do they ask for help? Any particular reason for stopping?	……………………………………… Go on to back of sheet if necessary

Appendix F: Initial River Bridge Interview Questions

Hi, my name is _____ and I am working at the Science Museum to study the exhibit you were just using called "River Bridge". Can I ask you a few questions about the exhibit?
It will help us to better understand our exhibits and our visitors so we can improve them for the future. It will only take about 5 minutes, if you are willing. Thank You.
** If under 17…
Can we find who you came to the museum with so we can get permission?
IF you don't mind, could we ask your child a few questions about the exhibit? It will help us to better understand our exhibits and visitors and improve them for the future. It will only take about 5 minutes if you are willing. Thank You. *There's no right or wrong answer.*

1. Was there any particular reason why you chose this exhibit, River Bridge?

2. Can you describe what you did at the exhibit?
    P1. Can you talk me through what happened at this exhibit?

3. How did you know what to do at this exhibit?

4. What did you particularly like about this exhibit?

5. What did you particularly dislike about this exhibit?

6. What do you think this exhibit is all about?

Questions if didn't use book
7. Did you notice the book? Yes / No

8. Is there any particular reason why you didn't use the book?

Questions if used book
9. Why do you think the book is there?
    P1. Was there anything in the book that helped you build a bridge?

10. What did you particularly like about the book?

11. What did you particularly dislike about the book?

12. Was there anything that you found difficult or confusing about the book?

13. What could we do to improve the book for you?

14. Who do you think the book is aimed at?

15. Is there any particularly reason why you say that?

16. Have you been to Launch Pad before?

17. Have you used River Bridge before?
    P1. Did the book help you compared to the last time you tried?

18. How old are you?

M / F

Questions to parents of child

19. How do you feel about having the book at the exhibit?
    P1. Do you feel that it is useful to have the book at the exhibit?

20. Is there any particular reason why you say that?

21. Do you have any suggestions about how we can improve the book or the exhibit?

Appendix G: Updated River Bridge Observation Sheet and Coding System

	Interview	M / F	Age	Time Start	Time End	Type of structure	Comments

Code:	Description:
3S	Simple 3-block structure
5S	Simple 5-block structure
C	Counterbalanced, 7-block structure
7A	Harder Structure such as Aztec or A-frame
A	Attempted structure
N	New structure

Appendix H: Updated River Bridge Interview Sheets

For Interviews With Trace on Gallery

Hi, my name is _____ and I'm working at the Science Museum to study the exhibit you were just using called "River Bridge". May I ask you a few questions about the exhibit? It will only take about 5 minutes if you're willing and will help us better understand our exhibits and visitors so we can improve them for the future. Thank you.
****If under 17……**Can we find whom you came to the museum with so we can get permission? If you don't mind, could we ask your child a few questions about the exhibit? It will help us to better understand our exhibits and improve them for the future. It will take about 5 minutes if you're willing. Thank you. **There is no right or wrong answer.**

1. What do you think River Bridge is all about?
   P1: What do you think River Bridge is trying to show you?

2. How did you know what to do at River Bridge?

3. Did you use the River Bridge Book on the table? Yes No

If NO:
4. Is there any reason why you didn't use the book?

5. Any other comments?

A. Have you been to Launch Pad before? Yes No

B. Have you used River Bridge before? Yes No

C. How old are you? _____

Male Female

Thank you so much for your time. Have a great day at the Science Museum. Would you like a sticker?

If YES:
6. Why do you think the book is there?

7. Was there anything in the book that helped you build a bridge?

8. What did you like about the River Bridge Book?

9. What did you dislike about the book?

10. Who do you think the book is aimed at?
P1: Who do you think would want to use the book?

11. Is there any reason that you say that?

13. If we were adding to the book would you want a picture of a bridge you made in it? Yes No

14. Any other comments?

A. Have you been to Launch Pad before? Yes No

B. Have you used River Bridge before? Yes No

12. Did the River Bridge help you compared to the last time you used River Bridge? How so?

C. How old are you? _____

Male Female

Thank you so much for your time. Have a great day at the Science Museum. Would you like a sticker?

Questions to Parents of Child
Would you mind if we also asked you a few questions? It will take about 2 minutes.

15. How do you feel about the book at this exhibit?
P1: Do you feel that having the book is useful?

16. Is there any reason why you say that?

17. Do you have any suggestions about how we can improve the book?

18. Any other comments?

For Interviews Without Trace on Gallery

Hi, my name is _____ and I'm working at the Science Museum to study the exhibit you were just using called "River Bridge". May I ask you a few questions about the exhibit? It will only take about 2 minutes if you're willing and will help us better understand our exhibits and visitors so we can improve them for the future. Thank you.
****If under 17……**Can we find who you came to the museum with so we can get permission? If you don't mind, could we ask your child a few questions about the exhibit? It will help us to better understand our exhibits and improve them for the future. It will take about 2 minutes if you're willing. Thank you. **There is no right or wrong answer.**

1. What do you think River Bridge is all about?
    P1: What do you think River Bridge is trying to show you?

2. How did you know what to do at River Bridge?

3. Any other comments?

A. Have you been to Launch Pad before? Yes No

B. Have you used River Bridge before? Yes No

C. How old are you? _____

Male Female

Thank you so much for your time. Have a great day at the Science Museum. Would you like a sticker?

Appendix I: Signs Used for Magnetic Wall Question 1 and 2

Question 1:

What do you think is inside the Plasma Ball?

See what other people think, or post what you think!

- Take a coloured card and write down what you think.
- Then post it on the board using a magnet.

Question 2:

How do you think plasma ball works?

See what other people think, or post what you think!

- Take a coloured card and write down what you think.
- Then post it on the board using a magnet.

Appendix J: Observation Sheet for Magnetic Wall

Interview	M/F	Age	Time	Looked @ ball	Read comments?	Type of comment?

Appendix K: Sign Used for Magnetic Wall at Shadow Box

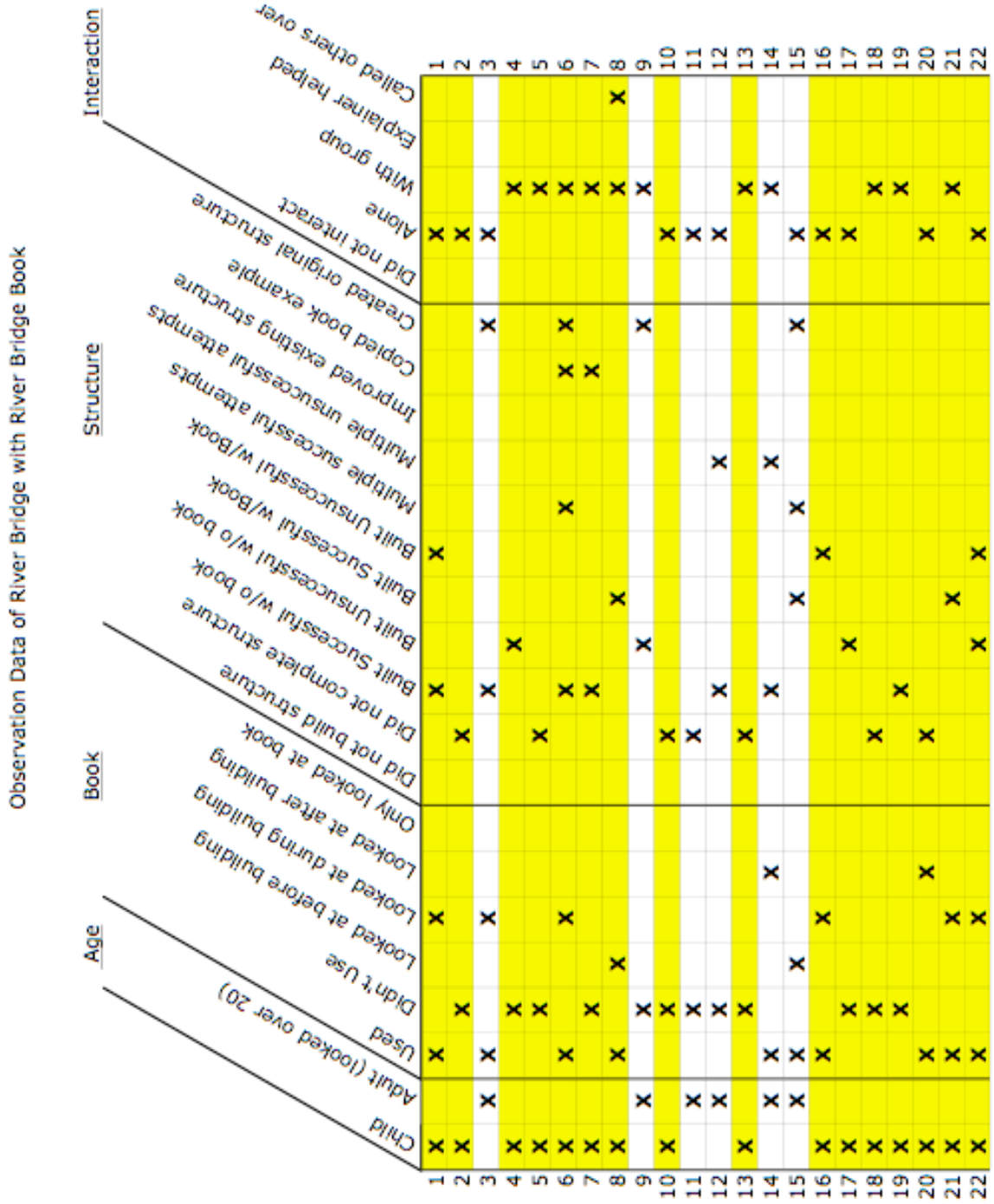
SEE BOARD OUTSIDE

draw a picture of the shadow you made!

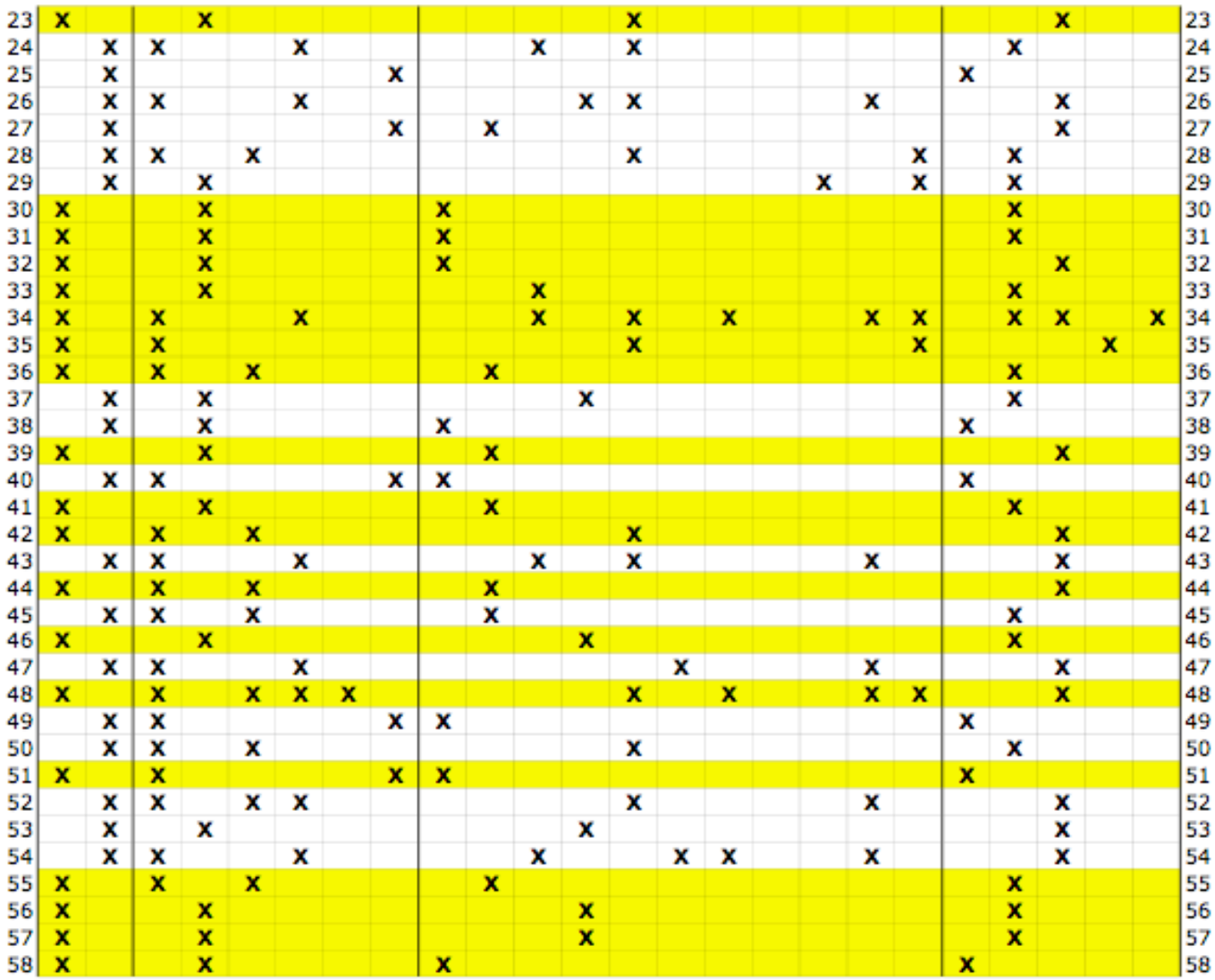
- Take a coloured card and draw the shadow you made in shadow box along with your name & age.
- Why do you think your shadow stayed on the wall?
- Post your card on the board using a magnet

Appendix L: Sign Used for Post-It Mural

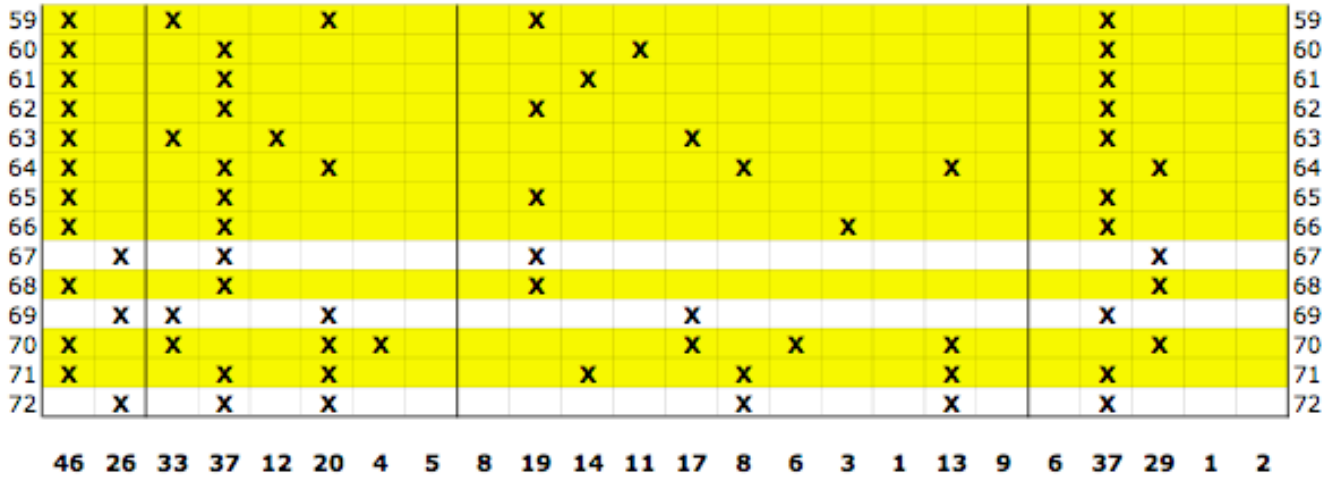
Appendix M: River Bridge Cycle 1 Observation Matrix



Observation Data of River Bridge with River Bridge Book



Observation Data of River Bridge with River Bridge Book



Appendix N: River Bridge Cycle 1 Interview Matrices

Interview Data

Without Trace: River Bridge Catalogue

Questions	Code	Answers Received	Answer	Percentages
1. Was there any particular reason why you chose this exhibit, River Bridge?	A1	No/Not really	3	37.5%
	A2	Wanted to get to extemely hard	0	0.0%
	A3	Something to do	1	12.5%
	A4	No one was using it	0	0.0%
	A5	Done it before, trying again	1	12.5%
	A6	It looked interesting	1	12.5%
	A7	Children	0	0.0%
	A8	Topic studying in school	1	12.5%
	A9	Couldn't do Hangover exhibit	1	12.5%
	A10	Challenging	1	12.5%
2. Can you desribe what you did at the exhibit? P1: Can you talk me through what happened?	B1	Tried to make a bridge the boat could go under	3	37.5%
	B2	Built easy to extra hard	0	0.0%
	B3	Tried out many ways/Trial and Error	1	12.5%
	B4	Built my own bridge	1	12.5%
	B5	Tried a structure from book	0	0.0%
	B6	Tried	0	0.0%
	B7	Built everything in book	0	0.0%
	B8	Easy, left children to use it	0	0.0%
	B9	No	0	0.0%
	B10	Built and easy one and succeeded	1	12.5%
	B11	Read instructions	0	0.0%
	B12	Tried the very hard level but did not work	2	25.0%
	B13	Built a bridge with counterweights	2	25.0%
	B14	Tried the hard level but did not work	0	0.0%
	B15	Did the hardest one	0	0.0%
3. How did you know what to do at this exhibit?	C1	Read sign	6	75.0%
	C2	Someone else did it	0	0.0%
	C3	Because of the book	0	0.0%
	C4	Done it before	1	12.5%
	C5	Have done a similar activity before	1	12.5%
	C6	Guessed/Figured out on own	1	12.5%
	C7	Parent/s	1	12.5%
	C8	Don't know	0	0.0%

4. What did you particularly like about this exhibit?	D1	Challenging for all ages/Challenging	3	37.5%
	D2	Strategic	0	0.0%
	D3	Trying to make the bridge	0	0.0%
	D4	Trying to find the right idea	0	0.0%
	D5	Nothing particularly	1	12.5%
	D6	Hands-On	0	0.0%
	D7	The Book (having structures kids built)	0	0.0%
	D8	The Red Blocks	0	0.0%
	D9	Well made exhibit	0	0.0%
	D10	Creative	0	0.0%
	D11	Students liked it	0	0.0%
	D12	Simple	0	0.0%
	D13	Teaches about forces	1	12.5%
	D14	Fascinating material	0	0.0%
	D15	When the bricks fall	1	12.5%
	D16	The boat	1	12.5%
	D17	Fun	2	25.0%
5. What did you particularly dislike about this exhibit?	E1	Nothing particularly	4	50.0%
	E2	Dropped block on toe	0	0.0%
	E3	Needs more blocks	1	12.5%
	E4	Difficult	1	12.5%
	E5	Frustrating/Can't do it	1	12.5%
	E6	The height of the boat pole	0	0.0%
	E7	The blocks falling down	1	12.5%
6. What do you think this exhibit is all about? P1: What do you think this exhibit is trying to show you?	F1	Building bridges/easy to hard	2	25.0%
	F2	Don't know	0	0.0%
	F3	Balance/Forces	3	37.5%
	F4	Engineering	0	0.0%
	F5	Moving things together	1	12.5%
	F6	Structure lessons	0	0.0%
	F7	Gravity laws	0	0.0%
	F8	Counterweights	2	25.0%
	F9	Construction	0	0.0%
	F10	To bridge a gap	0	0.0%
	F11	Suspension	0	0.0%
	F12	Weight of the bridge holding it up	1	12.5%
	F13	Scientific principles	1	12.5%
	F14	Encourages thought	1	12.5%
	F15	Pillars	0	0.0%
16. Have you been to Launch Pad before?	P1	Yes	4	50.0%
	P2	No	4	50.0%
If #16 is answered yes ask #17				
17. Have you used River Bridge before?	Q1	Yes	1	25.0%
	Q2	No	3	75.0%

19. How old are you?	S1	Under 8	1	12.5%
	S2	KS 2 (8-10)	2	25.0%
	S3	KS 3 (11-14)	1	12.5%
	S4	15-18	0	0.0%
	S5	19-25	0	0.0%
	S6	Over 25	4	50.0%
M/F	T1	Male	5	62.5%
	T2	Female	3	37.5%
		Total Interviews	8	

Interview Data

With Trace: River Bridge Catalogue

Questions	Code	Answers Received	Answer
1. Was there any particular reason why you chose this exhibit, River Bridge?	A1	No/Not really	8
	A2	Wanted to get to extemely hard	1
	A3	Something to do	1
	A4	No one was using it	4
	A5	Done it before, trying again	2
	A6	It looked interesting	3
	A7	Children	1
	A8	Topic studying in school	0
	A9	Couldn't do Hangover exhibit	0
	A10	Challenging	1
2. Can you desribe what you did at the exhibit? P1: Can you talk me through what happened?	B1	Tried to make a bridge the boat could go under	5
	B2	Built easy to extra hard	2
	B3	Tried out many ways/Trial and Error	1
	B4	Built my own bridge	3
	B5	Tried a structure from book	3
	B6	Tried	1
	B7	Built everything in book	1
	B8	Easy, left children to use it	1
	B9	No	1
	B10	Built and easy one and succeeded	1
	B11	Read instructions	1
	B12	Tried the very hard level but did not work	1
	B13	Built a bridge with counterweights	0
	B14	Tried the hard level but did not work	2
	B15	Did the hardest one	1
3. How did you know what to do at this exhibit?	C1	Read sign	8
	C2	Someone else did it	1
	C3	Because of the book	7
	C4	Done it before	1
	C5	Have done a similar activity before	1
	C6	Guessed/Figured out on own	4
	C7	Parent/s	0
	C8	Don't know	1

4. What did you particularly like about this exhibit?	D1	Challenging for all ages/Challenging	8
	D2	Strategic	1
	D3	Trying to make the bridge	2
	D4	Trying to find the right idea	1
	D5	Nothing particularly	2
	D6	Hands-On	1
	D7	The Book (having structures kids built)	2
	D8	The Red Blocks	1
	D9	Well made exhibit	1
	D10	Creative	1
	D11	Students liked it	1
	D12	Simple	1
	D13	Teaches about forces	0
	D14	Fascinating material	1
	D15	When the bricks fall	0
	D16	The boat	0
	D17	Fun	1

5. What did you particularly dislike about this exhibit?	E1	Nothing particularly	12
	E2	Dropped block on toe	1
	E3	Needs more blocks	1
	E4	Difficult	3
	E5	Frustrating	1
	E6	The height of the boat pole	1
	E7	The blocks falling down	1

6. What do you think this exhibit is all about? P1: What do you think this exhibit is trying to show you?	F1	Building bridges/easy to hard	5
	F2	Don't know	6
	F3	Balance/Forces	6
	F4	Engineering	1
	F5	Moving things together	1
	F6	Structure lessons	1
	F7	Gravity laws	1
	F8	Counterweights	1
	F9	Construction	1
	F10	To bridge a gap	1
	F11	Suspension	1
	F12	Weight of the bridge holding it up	0
	F13	Scientific principles	0
	F14	Encourages thought	0
	F15	Pillars	1

Questions if didn't use book

7. Did you notice the book?	G1	No	2
	G2	Yes	2

8. Is there any particular reason why you didn't use	H1	Didn't see it	2
	H2	No particular reason	2

Questions if used book			
9. Why do you think the book is there? P1: Was there anything in the book that helped you build a bridge?	I1	Courtney Age 8 Bridge	1
	I2	Samantha Age 11 Bridge	1
	I3	Helpful Hints/Help	6
	I4	Give guidance	3
	I5	The pictures	2
	I6	New ideas	3
	I7	Use solutions (cheat)	1
	I8	Couldn't have built a bridge without the book	1
	I9	Help children when they are stuck	2
	I10	To make more interactive for children	1
	I11	To encourage people/Show others work	3
10. What did you particularly like about the book?	J1	Didn't use it a lot (didn't answer)	1
	J2	Nothing particularly	1
	J3	The photos	4
	J4	The imaginitive structures	1
	J5	The comments/hints	7
	J6	The basic structures	1
	J7	Useful/Helpful when stuck	3
	J8	Cover	2
	J9	Younger children succeeded	2
11. What did you particularly dislike about the book?	K1	Didn't use it a lot (didn't answer)	1
	K2	Didn't particularly dislike anything	11
	K3	The blank pages	1
	K4	Were no warning for solutions needed	1
	K5	Needs more ideas	1
	K6	More photos and written instructions	1
	K7	Need more instruction on A frame structure	1
12. Was there anything that you found difficult or confusing about the book? *Referring to the entire exhibit experience	L1	Didn't use it a lot (didn't answer)	1
	L2	No	12
	L3	Could not build the hints	1
	L4	The whole thing was difficult*	1
	L5	The 3rd hint	1
13. What could we do to improve the book for you?	M1	Make the reason of the exhibit more obvious	1
	M2	Put book on the sign	1
	M3	Nothing	5
	M4	More writing/instructions	2
	M5	Have less answers	1
	M6	Don't know	2
	M7	Additional instructions on harder structures	1
	M8	More ideas/Make longer	4
14. Who do you think the book is aimed at?	N1	Ages up to 12	2
	N2	Children	5
	N3	Anyone who wants a go/All ages	5
	N4	People who are stuck	1
	N5	More adults	1
	N6	I don't know	1
	N7	Not adults	1

15. Is there any particular reason why you say that?	O1	Very visual/Less writing	1
	O2	Easy to understand	2
	O3	Don't know	3
	O4	No	7
	O5	Simpler structures for children and complex ones for adults	1
	O6	Launch Pad is for children	2
16. Have you been to Launch Pad before?	P1	Yes	6
	P2	No	11
If #16 is answered yes ask #17			
17. Have you used River Bridge before?	Q1	Yes	3
	Q2	No	3
18. Did the book help you compared to the last time you tried?	R1	Yes	1
	R2	No	1
	R3	Can't remember	1
19. How old are you?	S1	Under 8	0
	S2	KS 2 (8-10)	6
	S3	KS 3 (11-14)	6
	S4	15-18	2
	S5	19-25	2
	S6	Over 25	4
M/F	T1	Male	7
	T2	Female	13
Question to parents of child (if present)			
20. How do you feel about having the book at the exhibit? P1: Do you feel that it is useful to have the book	U1	Yes/Useful	4
	U2	It's alright; kids can do it on their own	1
	U3	Allows visitors to look for examples start	1
	U4	Could be used for cheating	1
21. Is there any particular reason you say that?	V1	Can achieve more complicated bridges	1
	V2	Used it to find the answer, better than walking away building nothing	1
	V3	So children know where to start	1
	V4	Difficult to use without the book	1
	V5	Don't show them everything/cheating	2

Appendix O: River Bridge Cycle 2 Observation Matrices

River Bridge 2nd Cycle Observation Matrix (with Trace)

	Interview	Male	Female	Under 8	8 to 10	11 to 14	15 to 20	21 to 50	over 50	Used	Didn't Use	Time Spent	Did not build structure	3 blk simple	5 blk simple	7 blk counterbalance	7 blk extremely hard	Attempted structure	Wrong Concept	New structure	Structure Successful	Structure Unsuccessful	Learning Successful	Learning unsuccessful	Alone	With group	Group member viewed book	Bridge discussion	Other discussion
1		X			X					X		01:16			1						X		X		X				
2		X			X					X		01:28						1				X	X		X				
3		X		X					X			00:32	1																
4			X	X								00:43							1			X	X		A	A			
5	A	X			X					X		03:12			1	1		1			X	X		X	A	X		X	
6	B	X				X						05:29			1	1		1		2	X	X		X		X		X	
7			X		X					X		01:10				1		1			X	X		X		X			
8		X			X			X				06:52			1	1		1			X	X		X					
9	C	X			X					X		05:38			1	1	1	1			X	X		X					
10		X				X					X	03:59								1		X	X	X					
11			X		X						X	00:20						1				X	X	X					
12		X	X		X			X		X		02:48		1				1	1		X	X	X	X					
13		X	X		X					X	X	01:30		1					1		X	X	X	X					
14			X		X					X		01:39						1				X	X						
15	D		X				X					05:28						2				X							
16		X	X			X				X		02:18		1		1					X		X						
17		X			X						X	01:54							1			X	X		F	F			
18		X	X			X					X	00:33	1											X					
19	E	X		X						X		03:04		1		1					X	X				X			
20		X			X	X				X		02:45				1	1				X	X				X			
21			X		X							01:00			1			1					X		A				
22			X		X						X	02:24		1										X					
23		X	X		X					X		05:13		1				1					X	X					
24		X					X			X		03:15						1					X	X					
25			X				X			X	X	02:16				1		1			X	X				X			
26		X				X				X		01:39						1					X	X					
27			X					X		X		03:04		1		1			1		X	X	X	X					
28	F	X				X				X		03:17						1	1			X	X	X				X	
29		X				X				X		00:35						1				X	X		X				

River Bridge 2nd Cycle Observation Matrix (with Trace)

30		X				X					X	01:05						1				X	X			X							
31	G	X					X			X		04:07						1				X	X			X			X				
32		X				X					X	01:03						2				X	X		X								
33			X		X							00:22	1												X								
34	H		X				X			X		12:26				1		3			X	X	X			X	F	X					
35	I		X				X			X		04:23				1		1			X	X	X		X								
36		X			X							03:00				1			1	1	X	X	X	X		X	A	X					
37	J	X			X						X	03:24					1	1			X	X	X			X							
38	K	X			X					X		05:50			1	1	1	1			X	X	X			X		X					
39			X		X					X		03:05		1				1				X	X			X							
40		X			X							00:28	1												X								
41		X					X				X	00:54						1				X	X		X								
42		X			X					X		02:25			1			1			X	X	X		X								
43		X				X				X		03:50						4				X	X		X								
44	L	X				X				X		01:35			1						X		X			X							
45			X		X						X	02:01						1				X	X			X		X					
46		X				X				X		02:25						1				X	X		X								
47		X			X						X	09:36				1		1			X	X	X			X		X					
48			X		X						X	01:31		1				1				X	X		X								
49	M		X					X		X		02:24						1	1			X	X	X		X							
50		X			X					X		00:40				1					X		X			X		X					
51		X		X							X	02:20						1				X	X			X		X					
52			X			X					X	00:28							1			X		X	X	X							
53			X		X					X		01:01							1			X		X		X							X
54			X			X					X	00:35						1				X	X			X							
55			X	X							X	01:25				1					X		X			X		X					
56		X		X								01:55						1				X	X			X	C	X					
57		X			X					X		04:54				1		1			X	X	X			X	C						
58	N	X			X							06:14			1	1		2			X	X	X			X	A	X					
59		X		X							X	01:10		1				1				X	X			X							
60		X				X					X	01:00						1				X	X			X							
61	O	X				X				X		04:38						2				X	X			X	C	X					
62			X		X					X		03:05				1		1			X	X	X			X		X					
63	P	X				X				X		08:15				1		4			X	X	X			X	A	X					
64		X			X						X	02:01						1				X	X			X		X					
65	Q		X		X					X		04:43						2				X	X		X	X		X					
66			X					X				00:40	1												X								
67		X				X					X	02:49				1		1			X	X	X			X		X					
68		X			X						X	00:50				1					X		X			X							
69		X		X								02:10						1		1	X	X	X			X	A						
70	R	X			X							02:01		1	1	1					X	X	X			X	A	X					
71			X		X						X	05:10				1		1			X	X	X			X		X					

River Bridge Observation Without Trace

	Interview	Male	Female	Under 8	8 to 10	11 to 14	15 to 20	21 to 50	over 50	Time Spent	Did not build structure	3 blk simple	5 blk simple	7 blk counterbalance	7 blk extremely hard	Attempted structure	Wrong Concept	New structure	Structure Successful	Structure Unsuccessful	Learning Successful	Learning unsuccessful	Alone	With group	Bridge discussion	Other discussion
1			X				X			01:23						1				X	X			X		
2		X					X			00:27		1				1				X	X		X			
3			X		X					01:28			1			1			X	X	X			X	X	
4		X				X				00:35						1				X	X		X			
5			X		X					00:23							1			X		X	X			
6	A		X			X				01:49		1	1			1			X	X	X			X		
7		X					X			01:07	1													X	X	
8		X					X			01:16						1				X	X			X	X	
9			X				X			00:57			1			1			X	X	X		X			
10			X			X				00:31						1				X	X		X			
11		X				X				01:51			1			1			X	X	X			X		
12	B		X		X					04:38			1			1			X	X	X			X	X	
13			X		X					02:50						1				X	X			X		
14		X			X					01:14						1				X	X			X	X	
15	C		X		X					03:01				1		1			X	X	X			X	X	
16		X			X					01:40		1						1	X	X	X			X		
17			X		X					01:40						1				X	X			X		
18	D		X			X				01:42		1				1				X	X			X		
19		X				X				01:21						1				X	X			X		
20		X				X				00:54						1				X	X		X			
21		X			X					01:00			1			1			X	X	X			X	X	
22	E	X				X				02:34			1			1			X	X	X			X	X	
23			X		X					00:33			1						X		X			X		
24			X		X					01:05						1				X	X			X	X	
25		X			X					01:05						1				X	X			X	X	
26		X			X					00:25							1			X		X	X			
27			X			X				00:50							1			X		X		X		
28		X				X				00:48						1				X	X			X		

River Bridge Observation Without Trace

29	F		X			X				08:34							1			X		X	X			
30		X			X					01:29						1				X	X		X			
31		X		X						01:07						1				X	X			X	X	
32	G	X			X					05:27			1	1		1			X	X	X			X	X	
33		X			X					12:38				1		1			X	X	X			X	X	
34			X			X				04:06						2				X	X			X	X	
35		X			X					05:43			1			1			X	X	X			X	X	
36			X		X					03:24			1			1			X	X	X			X	X	
37		X			X					04:42			1			1			X	X	X			X		
38	H	X		X						01:22		1				1				X	X			X		
39			X		X					02:22						1				X	X			X	X	
40		X			X					00:49						1				X	X		X			
41			X		X					01:27		1				1				X	X			X	X	
42			X		X					04:00						1				X	X			X*		
43	I	X		X						03:02			1	1					X		X			X	X	
44	J	X				X				05:20			1	1		1			X	X	X			X	X	
45		X				X				01:20				1		1			X	X	X			X		
46	K	X				X				01:17						1				X	X			X		
47			X		X					01:44						1				X	X			X	X	
48	L		X		X					00:45			1						X		X			X		
49		X				X				02:00		1				1				X	X		X			
50	M	X				X				04:37		1	1			1			X	X	X			X	X	
51			X			X				02:11			1			1			X	X	X			X	X	
52			X					X		00:30						1				X	X		X			
53	N	X				X				01:25						1				X	X		X			
54			X		X					01:18				1		1			X	X	X			X	X	
55			X					X		02:55			1	1					X		X			X	X	
56	O	X			X					02:12						1				X	X			X	X	
57			X			X				00:23	1													X		
58			X			X				02:26						1				X	X		X			
59		X				X				00:25						1				X	X		X			
60			X			X				00:58						1				X	X		X			
61			X		X					00:57		1				1				X	X			X		
62	P		X		X					05:49			1	1					X		X			X*	X	
63			X			X				02:09					1				X		X			X	X	
64			X	X						03:23						1				X	X			X		

River Bridge Observation Without Trace

65	Q	X				X				02:00						1				X	X			X		
66		X			X					00:14			1						X		X			X		
67		X			X					01:50			1			1			X	X	X			X	X	
68		X			X					00:52							1			X		X	X			
69	R	X				X				02:45		1				1				X	X			X	X	
70		X			X					00:41			1			1			X	X	X			X	X	
71			X		X					00:59						1				X	X			X		
72		X			X					01:47	1													X		
		38	34	4	35	26	5	2	0	02:09	3	10	22	9	1	56	5	1	28	62	64	5	17	53	31	

Appendix P: River Bridge Cycle 2 Interview Matrix

River Bridge Interview Data (round 2)
With Trace

Questions	Code	Answers Received	Answer
1. What do you think River Bridge is all about? *P1: What do you think River Bridge is trying to show you?*	1A	How to build a bridge	5
	1B	How balance works	3
	1C	How to build a proper structure	1
	1D	About balance, counterweights, and things	2
	1E	Center of gravity	1
	1F	basic engineering, physics	1
	1G	Not sure	1
	1H	How bridges work	1
	1I	How extension works	1
	1J	Build the bridge without falling down	1
2. How did you know what to do at River Bridge?	2A	Looked at book	5
	2B	Instructions from class/school	3
	2C	Guessed	2
	2D	Looked at sign	3
	2E	Didn't know what to do	1
	2F	Previous experience	2
	2G	Physics knowledge	1
	2H	from Parent	1
3. Did you use the River Bridge Book on the table?	3A	Yes	12
	3B	No	1
4. Is there any reason why you didn't use the book?	4A		
5. Any other comments?	5A		

6. Why do you think the book is there?	6A	To tell you what to do	1
	6B	To give people ideas	2
	6C	To help you	6
	6D	To show you how to improve designs	1
	6E	To show what others have done	1
	6F	To inspire ideas	1
	6G	To help people so they don't walk away thinking they cant do it	1
	6H	If you cant do the puzzle, you can look at what others have done	1
	6I	To show new ideas	1
7. Was there anything in the book that helped you build a bridge?	7A	1st design	1
	7B	The idea of making the blocks diagonally	1
	7C	The last design	2
	7D	It didn't help, struggled to build	1
	7E	yes	3
	7F	no, too hard	1
	7G	The pictures of final bridges	1
	7H	The second page helped	1
	7I	No, Looked at book after	1
	7J	Turning the blocks around	1
8. What did you like about the River Bridge Book?	8A	It helped me/was helpful	2
	8B	Fun to do	2
	8C	It was interesting	1
	8D	The way the bridges were built	1
	8E	Gave ideas	2
	8F	It showed other peoples work	4
	8G	Challenging	1
	8H	Had ideas/examples	2
	8I	Gave answers	1
	8J	Didn't try to teach you, it showed you and you had to figure it out	1
9. What did you dislike about the book?	9A	When the bridge fell down	1
	9B	Not enough blocks	1
	9C	That it told you how to do build	1
	9D	more ideas/answers	2
	9E	It was hard to take the time to look at the book	1
	9F	Not enough instructions	2
	9G	Nothing	4
	9H	Unfair, people can cheat	1

10. Who do you think the book is aimed at? *P1: Who do you think would want to use the book?*	10A	People who made a bridge	1
	10B	Younger people	6
	10C	People who like to build towers/buildings	1
	10D	People who don't know what to do/need help	4
	10E	Older people	1
	10F	10 year olds	1
	10G	lazy people	1
	10H	People trying to build the bridge	1
11. Is there any reason why you say that?	11A	No/Don't know	5
	11B	Because I am more mature	1
	11C	The comments were from younger kids	3
	11D	Quite complicated	1
	11E	I was lazy	1
	11F	The book is there	1
	11G		1
		People will want to see what others have done	
	11H		1
		Because I'm 21 and should know these things	
12. Did the book help you compared to the last time you used River Bridge? Howso?	12A		
13. If we were adding to the book, would you want a picture of a bridge you made in it?	13A	Yes	8
	13B	No	4
	13C	Maybe	1
14. Any other comments?	14A	It was fun	3
	14B	Not enough blocks	1
	14C	you can design your own bridge	1
A. Have you been to Launch Pad before?	AA	Yes	6
	AB	No	7
B. Have you used River Bridge before?	BA	Yes	1
	BB	No	12

15. How do you feel about the book at this exhibit? *P1: Do you feel that having the book is useful?*	15A	Yes	4
	15B	Definitely	1
	15C	Didn't really look at book	1
	15D	That was good	1
16. Is ther any reason why you say that?	16A	It showed me what to do	2
	16B	More interesting	1
	16C	Because otherwise you would give up in the end	1
	16D	After a go, you could look up how to do it	1
	16E	It helps to keep kids focused	1
	16F	Gives ideas outside the standards	1
	16G	It helped to explain the concept of exhibit	1
	16H	Showed more complicated designs	1
	16I	They can see what others have done	1
17. Do you have any sugguestions about how we can improve the book?	17A	No	5
	17B	More hints/starting points	2
	17C	More completed designs	2
18. Any other comments?	18A	No	7
	18B	Simple -> Complex	1

River Bridge (round 2) with Trace

Interview Responses to Question Received from Visitor

Interview	Observation #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	A	B	C	M /F	15	16	17	18
A	5	1A	2A	3A			6A	7A	8A	9A	10A	11A		13A		AB	BB	8	M	15B	16A	17A	
B	6	1B	2B/C	3A			6B	7B	8B/C	9B	10B	11B		13A	14A	AA	BA	14	M				
C	9	1C	2A/D	3A			6C	7C	8D	9C	10C	11A		13A	14A	AB	BB	9	M	15D	16A/B	17A	18A
D	15	1D	2D	3A			6C	7D	8E	9D	10B	11C		13B		AA	BB	15	F	15A	16C/D	17B	18A
E	19	1A	2C/A	3A			6D	7E	8F/B/G	9E	10D	11A		13A		AB	BB	7	M	15A	16E	17A	18A
F	28	1E/J	2D	3A			6E/F	7C	8E	9D	10E	11D		13A		AA	AB	11	M	15A	16F/H	17C	18A
G	31	1A	2E	3A			6C	7F	8I	9F	10F	11A		13A		AA	AB	17	M				
H	34	1A	2A	3A			6C	7G	8F	9G	10B	11C		13B		AB	BB	17	F				
I	35	1F	2G/F	3A			6G	7H	8J	9G	10G/B/D	11E		13B	14B	AB	BB	18	F				
J	37	1G	2H	3A			6C	7E	8E	9F	10D	11A		13A		AB	BB	11	M	15A	16G	17A	18A
K	38	1B/H	2A/D	3A			6E	7E	8F	9H	10H	11F/G		13C	14C	AA	BB	10	M	15A	16H/I	17B	18B
L	44	1I/J	2B	3B			6I	7I	8F	9G	10B/D	11C		13A		AA	BB	13	M	15C			18A
M	49	1A/B	2G	3A			6C	7J	8H	9G	10B	11H		13B		AB	BB	21	F				18A
N	58	1D	2F	3B	4A											AA	BB	10	M				
O	61	1F	2A	3A			6C	7G	8K	9F	10H	11I		13A		AB	BB	14	M				
P	63	1G	2A	3A			6C	7K	8B	9D	10B/I	11J		13D		AB	BB	11	F	15A	16A	17C	18A
Q	65	1G	2A	3A			6C	7E	8D	9G	10D	11A		13A		AA	BB	9	F	15A	16I	17B	
R	70	1G	2A	3A			6C	7E	8H	9G	10B	11A		13D		AA	BB	10	M				

Appendix Q: Type of Conversation observed

With Book:

Challenge	"Let's reach extremely hard" "Let's make a harder one" "You can make it higher I know" "Let's get further"
Negative	"I give up"
Book related	"Well done BOB 32" "This book is of people who have done it" "Look at the book" "That's what we did"
Correct concept	"Build bridge that sticks out over river" "Centre of gravity need to be here" "Just get it balanced"
Instructional	"Move this back" "Maybe put these on their ends"
Level of difficulty	"That's an easy one" "It's easy" "That's the easiest" "That was hard" "That one makes more sense"

Without Book:

Need more blocks	"Need another block" "Not enough blocks" "We've got two spare blocks" "Not fair that you get this many bricks, in real life you get more"
Correct concept	"You've got to counterweight it" "Build a bridge"
Negative	"It's not going to work" "That won't fit under" "How the hell does that work"
Challenge	"But now let's get hard" "Try to get to hard" "Get to very hard"
Instructional	"I know how to do it" "I'm trying to put it closer together" "Tell me what to do"

Without Book: Negative, challenge, correct concept, instructional, need more blocks
With Book: Negative, challenge, correct concept, instructional, level of difficulty, book related

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Alex Burch to Victoria Briand, March 14, 2006, Email (Background feedback)

Alex Burch to Victoria Briand, April 13, 2006, Email (Museum policy on graffiti)

Compilation of Known Traces

Contents:

Existing Trace in Museums:

- Gobstopper mural
- Energy Ring
- Worm wall
- Save System
- Stag and Man story
- Dan's art tours
- Turner Prize
- IN Future gallery
- Trace of visitors movement through a gallery
- Wailing Wall Exhibit
- Sand Trace in Israel
- Memory Book
- Innovation Forum
- Television V-Chip
- Index Cards
- Comment Books
- Holocaust Book
- Share your Reaction exhibits
- Trace postcards
- Post it Trace
- Personal Archive
- Show-off shelves
- Scott Snibbe's maps of the unseen
- Scott Snibbe's deep walls
- Tree climbing animal
- Build your own tree house
- Digital Spin Browser
- Dig Site
- Visitor Comment System
- PDA book marking system
- Human or Machine voting exhibit
- Visitor pictures at the Eiffel Tower
- DNA experiment
- Robot arm
- Discussion Exhibits

WPI potential trace ideas:

- Launch Your Drawing into Orbit
- Scientist Lab Notebook
- Be a Scientist
- Creative Building Workspace
- Question Board on gallery "what did you find out today?"
- Shadow box pictures

Recent ideas from meetings:

- Moving structure (car or robot)
- Roller coaster 3D simulation
- Images made of individual passport photos
- Open-Ended Challenges
- Liquid crystal wall of hands

Existing Trace in museums:

Mural made of gobstoppers at the Science Museum, London: Community artist worked with kids on developing a mural. Each child added to the mural. Then received a bookmark containing the part they had contributed. Located near the entrance of Launch Pad.

Energy Ring at the energy gallery at the Science Museum, London: Visitors are asked questions about various topics of general concern that relate to energy. The ring displays the question and answer along with the initials and age of the visitor.

Worm wall at the Wellcome Wing at the Science Museum, London: This is a feedback system where visitors were asked questions and their feedback is displayed on a worm wall that goes through every level of the gallery.

Save System at the Science Museum, London: this exhibit allows visitors to bookmark their comments and creations and then having it sent to them electronically.

Stag and Man story at Victoria & Albert Museum, London: Visitors looked at the artwork of the Stag and Man story and then were asked to write a story about what was going on in the painting. These stories were included in a catalogue for other visitors to read.

Dan's art tours at the Wellcome Wing, London: People create their own artworks and take digital photos of them, which are then sent to them as a postcard a week after their visit.

Turner Prize at Tate Britain: People hang their comments in a room at the end of exhibition. The room is filled with comments about what people thought of the exhibit and the controversial issue at hand. www.tate.org.uk/britian/turnerprize/2005/deafult.shtm

IN Future gallery at Science Museum, London: Visitors get to play a game about a controversial issue for the future. After the game, they are asked to vote for or against the proposed idea. Voting results are then showed after the exhibit is finished.

Trace of visitors' movements through a gallery by Scott Snibbe: The path a visitor took around a gallery was shown. Each visitor was represented as a dot on the screen. Other visitors could then scroll through to see past movements.

Wailing Wall Exhibit in Jewish Children's Museum in Los Angeles: Children were provided with paper to write their comments after seeing a replica of the Wailing Wall. The comments were then stuck on the replicated wall.

Sand Trace in Israel: People brought sand from their home to the museum and put it into a container that is displayed for viewing. This trace element was done to show how all people come from the same earth and served as a message of peace.

Memory Book at Sixth Floor museum at Dealey Plaza in Dallas: Visitors could record their thoughts after visiting the site where evidence from JFK's assassination was displayed.

Innovation Forum at Tech Museum of Innovation in San Jose: Visitors were encouraged to record their own thoughts, which were then made available for display as part of the exhibit.

Television V-Chip at Tech Museum of Information in San Jose: This exhibit introduces the issues of controlling the impact of "bad" TV content on the public. Visitors would record their opinions on paper about the V-chip and use of television. Thoughtful comments are saved in a binder for others to see.

Index Cards at the Monterey Bay Aquarium: Visitors used index cards to record their opinions about ocean conversations. These cards were then displayed on a wall.

Comment Books at Bradbury Science in Los Alamos: Visitors filled 18 ledger books over 6 years with comments about an exhibit on alternative perspectives on nuclear weapons.

Holocaust Book at the US Holocaust Museum in Washington, DC: Visitors can write their comments in a book after seeing the exhibition.

Share your Reaction exhibits at the Art gallery of Ontario in Toronto: Visitors were encouraged to relate the personal associations they had with the paintings on display. Visitors could draw or write comments on cards that were posted on boxes. This was developed for the OH! Canada project, where visitors could write or draw their responses to questions about the Canadian environment. Specific questions were displayed each week in the exhibition and in newspapers and on the Internet. Various forms of feedback were used such as: response cards, graffiti wall, video feedback and feedback via the Internet and by fax machine.

Trace postcards at the Walsall Museum and Art Gallery, UK: Children could take home stamped-addressed postcards to draw what they remembered of the exhibition. Visitors were also asked to vote on their most and least favorite paintings in the collections, the best comments were then used as text for the paintings.

Post it Trace at the Pump House: People's History Museum in Manchester, UK: Visitors can write their comments on post it notes and stick them to a wall.

Personal Archive at The Museum of Me, London: Each visitor was able to write about themselves on paper, blackboards and walls. They were also able to pick a favorite fabric, mark their location with a pin on a map, or measure their passion levels on a fairground machine.

Show-off shelves: LEGO models and structures created by previous visitors are displayed in a show-off shelf. Visitors are encouraged and challenged to build structures similar or

even better than what they see. Good structures would be put on display on the shelf with the name and age of the visitor.

Scott Snibbe's maps of the unseen e.g. at New York Hall of Science

Scott Snibbe's deep walls: Video footage of people's shadows is shown on display on a screen. Other visitors can do their own videos and will then be added to the screen. (http://www.snibbe.com/scott/mosaics/deep%20walls/deep_walls.html)

Tree climbing animal at the Ecotarium, Worcester MA: Visitors are asked to build their own tree climbing animal out of foam tubes and hang it on a tree.

Build your own tree house at the Ecotarium, Worcester MA: Visitors were given rods and connectors that were used to build a unique tree house. The tree house was then left for other visitors to view or change.

Digital Spin Browser at the Ecotarium, Worcester MA: This device was used at the Ecotarium to monitor an aquarium. Visitors could scroll through time-lapse video up to several weeks to see how the sea animals had moved. More information about this device could be found at www.technofrolics.com

Dig Site at Worcester Art Museum, Worcester MA: Children were provided with sheets to record their findings and write comments about the results. All drawing cards displayed in a catalogue for other visitors to see.

Visitor Comment System at Worcester Art Museum, Worcester MA: A computer was available so visitors could leave comments about their visit.

PDA Book Marking System at the Boston Museum of Science, MA: Visitors are given a PDA interactive device that has additional information and explanations about exhibits. Visitors then have the choice to enter their e-mail address and receive additional articles and information about exhibits they like.

Human or Machine voting exhibit at the Boston Science Museum, MA: This exhibit illustrates the effects of installing technology into human beings. Three visitors sit around the exhibit and each of them is asked to include a technology chip into a human. After the experiment, visitors are asked to vote on whether technology should be implemented into human beings or not and all the previous results from the poll are displayed.

Visitor pictures at the Eiffel Tower, Paris: Visitors had their pictures taken at the Eiffel tower and went online to access it. This was useful because they can only access their pictures from the web and the photo was free. This was a unique experience because visitors could go into a part of the web others can't see using an ID.

DNA experiment at Tech Museum: Visitors were able to transfer DNA to a jellyfish. The process would take 24 hours and they can log on to see the results.

Robot arm in Lintz Museum Garden: The arm has a camera, seeds and water and is controlled by virtual community that tells it what to do. Here visitors feel that they are actually doing something by growing flowers and the camera allows for checking progress.

Discussion Exhibits: such as Future Foods, Join the Great Fat debate, Tell System and The Big Bang. Discussion exhibits are areas where visitors can write their opinions or questions about issues covered by the exhibition. Visitors are asked a variety of open-ended questions and their responses are recorded in these exhibits.

WPI Potential Trace Ideas:

Launch Your Drawing into Orbit: This idea involves getting Launch Pad visitors to draw a picture that relates to an existing exhibit or represents a part of their visit that was memorable. The goal of the trace is to get visitors thinking about what they have just experienced. The trace would involve setting up an area of Launch Pad with tables and chairs that contains various creative writing utensils and paper. Also, a wall section close by to the station could be used to post drawings and names of other visitor's creations.

Scientist Lab Notebook: This trace idea consists of an exhibit related notebook. The notebook would include space for comments about exhibits, colour-in drawings, further explanations and questions about each exhibit. A picture of the visitor can be taken and posted to the cover of the notebook. The lab notebook will be a personalized memory of each visitor's Launch Pad experience. The notebook is intended to include materials relating to six of the scientific areas of Launch Pad. The material in the lab notebook should relate to the United Kingdom National Curriculum for key stages two and three in the area of science

Be a Scientist: The "Be a Scientist" idea is a trace that is aimed at allowing visitors to feel like actual scientists conducting research. The trace appeals to individuals' desires to dress up. Lab coats and goggles will be provided to be worn in a Launch Pad photograph.

Creative Building Workspace: Visitors will be asked to create physical objects in order to express their thoughts about exhibits by using Magnetix and creative building blocks**.** The creations will be left in an open exhibit area for other visitors to add more to if they wish.

Question Board on Gallery "What did you find out today?": Children are asked to write about their experience at Launch Pad and their responses would be posted on a wall. This

could be done by using magnetic words. The sentences could already be started to ensure specific content was resulted.

Shadow Box Pictures: A picture would be taken of the shadow that children made and the pictures could then be posted on a wall or put into a catalogue. The shadow pictures can also be given to children or posted on an online web page.

Recent Ideas from Meetings:

Moving structure (car or robot): This idea involves having kids build structures as cars or robots and race them. The fastest and most original structures would be left at the gallery for other visitors to see.

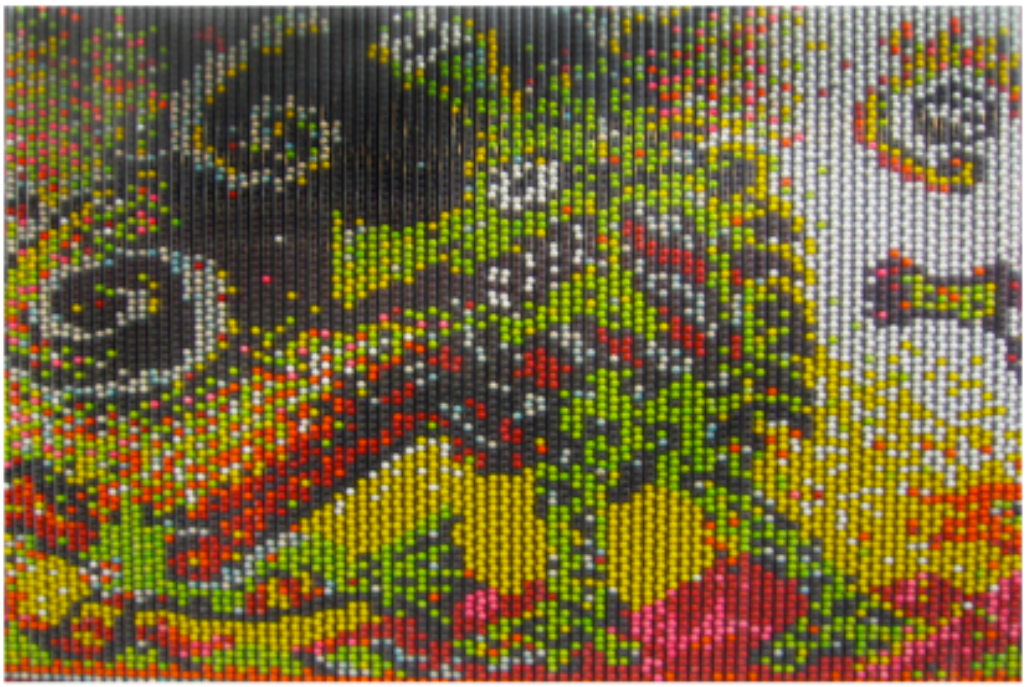
Roller coaster 3D simulation: visitors are asked to build their own roller coaster and test it in a 3-D simulation vehicle. This exhibit includes a challenge to show the fastest, steepest, and most twisting creations. A list of the top ten creations can be posted.

Images made of individual passport photos: Visitor's individual pictures were combined together to make a big picture.

Open-Ended Challenges: Traces based off of exhibits where there is no solved scientific reasoning (e.g. string loop at Exploratorium). The trace would have a statement asking people to suggest how and why it works.

Liquid crystal wall of hands: This would involve a large liquid crystal wall. Visitors could then touch the wall and leave their handprint behind for a short period of time.

Guidelines for the Design & Implementation of *Trace*



WPI

science museum

About the Guidelines

This guide has been developed to assist with the development of trace in museum galleries. It contains essential information about things to consider when implementing trace. The guide aims to provide assistance to museum staff who wish to understand what trace is, why it's important and how to develop an effective trace.

Guidelines Creation

These guidelines were created by students from Worcester Polytechnic Institute in Worcester, MA, USA. The guidelines are a result of the 14-week project "The Design and Implementation of Visitor Traces for the Launch Pad Gallery" which was done at the London Science Museum. The authors, Abdullah Azhari, Victoria Briand, Candace O'Connor and Courtney Titone completed the project to fulfill the Interactive Qualifying Project requirement of their Bachelor of Science degrees. This guide contains the conclusions that resulted from this work.

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What is Trace?

Trace is a way for visitors to leave behind a reminder of their visit to the museum. Trace can help to increase engagement and learning which can improve a museum's ability to achieve its learning objectives. A trace is used to alter visitors' behaviour. The creation of a trace allows visitors to generate thoughts about an exhibit's content while hopefully increasing creativity, engagement time and socialization.

Trace is a way for visitors to leave behind a reminder of their visit to the museum.

Trace can be used to incorporate many cognitive, personal and social aspects into a gallery. By including a range of roles, the learning objectives of a gallery can be expanded or enhanced. Trace can be used to inspire creativity and instill curiosity about an exhibit or science concept. Trace could be used to include more cognitive agendas such as reflection and cognitive understanding.

Range of Trace Roles	
Creativity	Curiosity
Personalization	Cognitive
Sense of community	Reflection
Socialization	Challenge

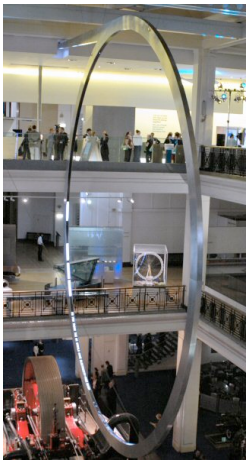
In addition to the cognitive, personal and social roles, trace can be used to accomplish additional agendas such as target specific audiences and labeling. Traces, which are personalized reminders of who has visited the gallery, can influence visitors' perceptions of the intended audience of the gallery. By viewing feedback of younger or older participants, the notions of a perceived audience can be defied. Trace could also be used as a creative way of labeling. It could be utilized as a way of offering instructions or guidance. Instead of having museum based instructions visitors creations, comments, hints or solutions could be used to guide other visitors' behaviour.

Research has shown that people who participate in trace, generally like the idea. Unlike other aspects of life where people are encouraged to leave nothing behind, such as garbage, graffiti, or belongings, trace allows visitors' to show other people their experience or accomplishments while visiting.

Some Specific Examples of Trace

In attempting to understand trace, it is helpful to look at existing examples. Two examples of trace, the “Gobstopper Mural”, “Energy Ring”, and the are discussed in this section. Each example has qualities that affect the role it plays in its museum or gallery. These examples are just a brief look at the many ways to create trace. See Additional Resources section for where to find more examples of existing traces.

Gobstopper Mural



Energy Ring

Gobstopper Mural: London Science Museum

The Gobstopper Mural was created through the collaboration of a community artist with local children. The Mural, located in the basement of the museum, is a very large image created out of thousands of individual gobstopper candies. Each child who participated added a sequence of gobstopper candies to the predetermined outline. Every child’s contribution came together to form a mural.

Energy Ring: London Science Museum

The Energy Ring is a large “attention grabbing” ring, located at the entrance to the London Science Museum, which displays visitors’ responses to questions. Feedback stations, located around the ring, pose questions to visitors that ask about their opinion on the future of energy. The question along with each visitor’s response, name and age (with delayed feedback) is then shown on a large ring located at the center of the museum.

Dimensions of Trace

There are many categories or "dimensions" that trace can fall under. Understanding the implications of each dimension will help in the planning process. The combinations of dimensions give each trace a very different role and allow for very different experiences.

Dimension	Category	Definition
1	*High Tech*	Innovative technology
	Low Tech	Simple, inexpensive and easy to implement
2	*Facilitated*	Needs to be staffed or attended too
	Unfacilitated	Able to function without assistance
3	*Exhibit Oriented*	Connected to a specific exhibit or concept
	Stand Alone	Not related to a certain exhibit content but to a group of exhibits, a gallery or the whole museum
4	*Structured*	Limited number of outcomes possible, if any. Focus directed at certain aspects
	Unstructured	Very open-ended, unpredictable outcomes
	Multi-Outcome	Allows for many different outcomes
5	*Delayed*	Feedback not seen by visitor different lengths of delay possible
	Immediate	Feedback immediately displayed
6	*Progressive*	Visitors participate in the creations of something and then check the progress "growing or changing" creation
	Collective	Outline for a predefined structure that visitors can alter or add onto in the gallery
	Competitive	Recording visitors' performances on an exhibit. For example; recording highest scores on a game exhibit, recording shortest times to complete an exhibit
7	*Family*	Intended for smaller groups i.e. would work better on weekends with family groups
	School group	Intended for larger groups, i.e. able to be used in school group setting

Dimension 1: Low vs. High Tech

Trace can be divided into low vs. high tech. Low-tech trace can be as simple as a post-it or note card left with a visitor's comment. A low-tech trace is generally less expensive and often easier to implement than a high-tech trace. The Gobstopper Mural at the London Science Museum is an example of a very low-tech trace while their Energy Ring is an example of a high tech trace.

Dimension 2: Facilitated vs. Unfacilitated

Trace, like exhibits, can be designed to work with or without assistance. A trace that requires the assistance is facilitated. Facilitation involves issues such as deciding will be staffed or rely on parental guidance. The Gobstopper Mural was facilitated in that it was staffed at all times in order to direct the behaviour of the participants. The artist was present to instruct children where and how to place the gobstoppers. Had this trace not been facilitated, the final outcome would have been vastly different.

Dimension 3: Exhibit Oriented vs. Stand Alone

A trace can be associated with a specific exhibit or the whole gallery. This is seen in again comparing the Gobstopper Mural to the Energy Ring. The Mural was not connected to any specific gallery or science concept. The Energy Ring was designed to obtain feedback specifically about visitors view on energy.

Dimension 4: Structured- Unstructured- Multi-Outcome

Trace, like exhibits, can have various levels of structure and many different outcomes. A structured trace leaves very little open to visitor alterations or creativity and is designed to direct the visitor's attention to specific parts of the scientific phenomena. For example, this can be done by asking a certain question or providing a diagram for visitors to fill in. Unstructured traces do not eliminate all visitor creativity but it is not as open-ended and unpredictable. An unstructured trace is one in which creativity and use of imagination is promoted. Although with unstructured trace there is the issue of monitoring for rubbish and offensive comments.

Dimension 5: Delayed vs. Immediate Feedback

One issue that was observed when comparing traces is that some people never observed the results of their own trace displayed. The trace was only viewed by future visitors. This issue of delayed feedback ties into Dimension 4. A trace which is unstructured more often will utilize delayed feedback. This is due to the very creative minds of visitors and the range of answers possible (potential for rubbish or offensive content). A decision was made for the Energy Ring at the London Science Museum to utilize delayed feedback. Immediate feedback allows the visitor to see their contribution without any delay. Immediate feedback can be problematic for unstructured traces since all visitors may observe rubbish or offensive comments unless a monitoring system is created. Another issues to consider is the affect of this delay on the experience of the person who participated in the trace

Dimension 6: Progressive- Collective- Competitive

Another dimension of trace is associated with the main objectives of the setup. Is the trace an ever-changing structure, a visual of multiple visitors' contributions, or a challenge imposed on visitors? A progressive trace keeps changing. The ever-changing factor allows visitors to revisit and check on the progress. It offers an incentive to see the end product, although it technically

never has to reach a final stage. A trace that is collective requires multiple visitors' contributions to reach a final stage. Collectivity was one of the key dimensions of the Gobstopper Mural. The Mural required contributions from a large number of visitors before the final picture could be seen. A competitive trace is one in which visitors compete against current or previous visitors' accomplishments.

Dimension 7: Family vs. School Group

Some types of trace tend to be more effective in a family setting while other traces are designed for the school group setting. A trace that requires facilitation would be harder to use when school groups are in a gallery due to the lower adult-to-child ratio. Family groups (children with their parents' supervision) are able to engage in activities that need some facilitation because the adult-to-child ratio is higher. This dimension also ties into Dimension 2 (facilitation vs. unfacilitation). A facilitated trace may have to be used on family group days and likewise with unfacilitated on school group days.

Planning for Multiple Dimensions: By including multiple dimensions, an engaging and diverse trace experience can be offered. Providing trace experiences that only express a single dimension limits the range of roles offered by trace, i.e. creativity, personalization, or experience.

The 7 dimensions can be used to understand the key differences between traces. The three examples of trace previously discussed each have different key points:

Gobstopper Mural:	**Energy Ring**:
• Low tech • Facilitated • Stand Alone • Structured • Immediate • Collective • Family	• High tech • Unfacilitated • Exhibit Oriented • Multi-outcome • Delayed • Progressive • Family or school group

Planning Resources for Successful Trace

The following section contains questions and considerations are intended to help guide you through some of the process of planning, implementing, and assessing the efficiency of trace in your museum.

How will the trace be maintained?

Like technology, certain aspects of a trace may not last forever. In order to have the most innovative and up-to-date trace, a plan for maintenance and redevelopment should be considered. Some essential considerations are as follows.

- *Broken parts*: Will replacements be readily available or need to be specially made?
- *Scheduled cleaning and upkeep*: Will the trace need to be rebuilt or attended to daily?
- *System updates*: If computerized, will the software need to be updated regularly to keep the trace in operation?
- *Technology updates*: Will the new technology quickly become old technology?
- *Old ideas or concepts*: Will the content become outdated quickly?
- *Redevelopment*: Will its redevelopment be a complicated process or easily accomplished?
- *Expected lifetime*: Is the trace setup going to last 1 month, 6 months, a year? When will the trace require a major refurbishment or redesign?

Another issue when considering staffing is the problem of “too much trace”.

For example: An open-ended discussion trace has been designed and placed on gallery. The trace is very popular and is getting an overwhelming amount of responses. What happens when the display area is full?

- What is the holding capacity, i.e. number of visitor comments that can be accommodated?
- How will the system be emptied?
- What will be the disposition of the “excess trace”?

Whether the trace is low or high tech, there is a point where there is no remaining free space. This is important to consider when planning on staffing or maintenance for the trace. In addition to too much trace, traces may have to be removed due to rubbish or offensive comments. How will offensive comments be dealt with, i.e. staff removal, delayed feedback?

Will the trace be staffed?

When planning for maintenance and rubbish comments, staffing may be considered. Staffing is also an option when examining Dimension 2 (facilitated or unfacilitated). A trace may benefit from having a staff member's full attention or it be fine with just having frequent may just be a minor task. The trace could be fully run by staff, in that participation is not an option without staff member present.

- Will the trace require constant or occasional staffing?
- Will dedicated staff be required?

How much will the trace cost?

The development and implementation of trace experiences requires an initial capital investment by the museum. But it is also important to recognize that most forms of trace will also require additional periodic expenditures for facilitation, maintenance, and upkeep. Depending on the trace, the cost of renewable supplies might also be an expense. These are all issues to keep in mind when designing a trace.

- Will the trace require weekly/ monthly/ yearly funds, i.e. such as note cards, pencils, or web space?
- What if it malfunctions or breaks, repair costs?
- Will visitors be charged to use the trace to help cover its cost?

Exhibit Types for Desired Trace Roles

There are many different types of exhibits that can benefit from the addition of exhibit specific trace, each with different factors that trace can alter or enhance. Three important types of exhibits to consider are active prolonged engagement (as studied by the Exploratorium, San Francisco, CA), short engagement and discussion exhibits.

Active Prolonged Engagement (APE) Exhibits

The term APE, created by the Exploratorium, refers to an exhibit that allows visitors to create their own scientific investigation (Tisdal, 2004). APE exhibits allow for longer engagement times than non-APE exhibits. Once visitors are engaged, the activities rely on their decisions and can continue down many different paths. The exhibits require experimentation, observation and contemplation (Tisdal, 2004).

Two examples of APE exhibits are River Bridge and Hangover Problem, both of which are found in the Launch Pad gallery at the London Science Museum.

- **River Bridge**: The goal of the exhibit is to build a bridge that is a certain distance and height (able to span a river and allow toy boat to pass under) by utilizing the concept of counterbalance. Seven blocks are provided which can be used in many different combinations to reach the outlined Easy, Hard, Very Hard and Extremely Hard levels.
- **Hangover Problem**: The goal of this exhibit is to utilize seven blocks in creating an overhang. The further the overhang of the blocks, the higher the level of difficulty that is achieved. The concept of counterbalance is needed to achieve the higher levels.

APE exhibits are particularly interesting because the length of time spent at the exhibit leads to many different behaviours which trace can alter. In addition to the traditional alterations such as exhibit design, interventions, extensions or different interpretation, trace can also alter the desired behaviors. Varying and experimenting with particularly Dimensions 4 (Structured- Unstructured- Multi-outcome) and 5 (Progressive- Collective- Competitive) is useful when creating an APE exhibit trace. This is due to that fact that there is not just one way or one correct answer. The visitors can interact with the trace and then spend additional time altering and exploring the scientific phenomena or vice-versa.

Other Considerations:

- Does increasing the time spent at one exhibit take away from time spent a) at other exhibits b) in the gallery c) at the museum?
- Does increasing knowledge of one scientific concept affect understanding of other exhibits and concepts in a gallery?

Short Engagement Exhibits

Short engagement exhibits, also referred to as illustration exhibits, are exhibits at which visitors tend to have quicker interactions. The exhibits tend not to facilitate multiple attempts and also do not have multiple outcomes, which can be manipulated by the visitor. They do illustrate scientific phenomena but often do not allow for further exploration. The visitor can have a successful experience in a relatively short time frame.

Two examples of short engagement exhibits are Shadow Box and Plasma Ball, both of which are found in the Launch Pad gallery at the London Science Museum.

- **Shadow Box**: This exhibit allows visitors to view their own shadow. A flash along with a photo-luminescent wall are used to capture the visitors' body positions. The shadow then remains on the wall for a short time for them to view.
- **Plasma Ball**: The Plasma Ball is a glass globe that contains a central electrode with electricity flowing through it. Visitors are able to touch the ball and watch the electricity flow towards their hand.

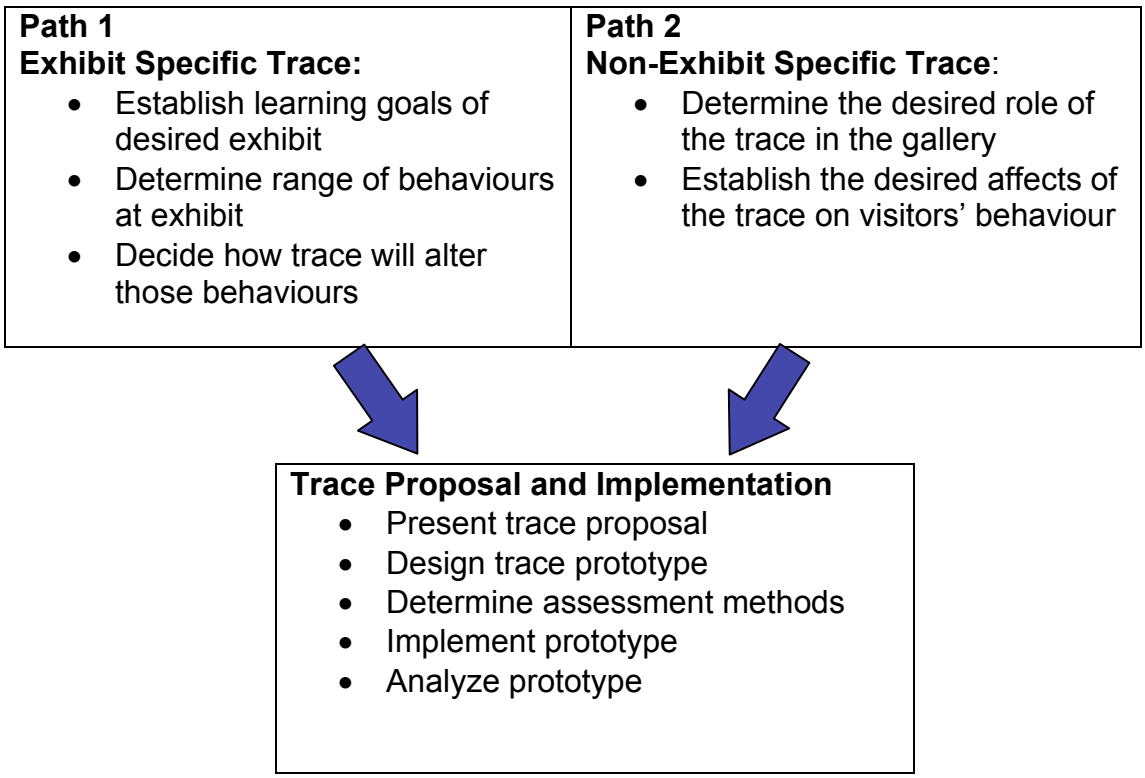
Short engagement exhibits pose a challenge when considering the addition of trace experiences. The issue arises of whether behaviour alterations can be made at exhibits traditionally classified as short-engagement, which tend not to facilitate longer and more contemplative engagement.

Discussion Exhibits

A discussion exhibit allows visitors to express their opinions on issues presented in an exhibition (sort of "trace exhibit"). The discussion could stand-alone or accompany a specific exhibit. The participation in the discussion is essential to further engage the visitor in the topics at hand. It also provides a convenient way to integrate trace into the exhibit. For example in the "Join the Great Fat Debate" exhibition at the London Science Museum, there was an exhibit that asked visitors what they think about Olestra. The comment book that was created then displayed the publics' perspective on the issues at hand.

Trace Design & Implementation Process

In creating trace there are two paths to follow, exhibit specific trace or non-exhibit specific trace (stand alone trace). The initial steps of each vary but then combine to follow common steps.



Path 1: Exhibit Specific Trace

Establishing the learning goals of the exhibit

When deciding to design an exhibit specific trace, it is essential to determine the original goals of the exhibit. What was the exhibit designed to do? What science was it intended to convey? The learning goals should be clearly stated before the exhibits success can be determined.

Sample Learning Goals of an Exhibit about Electricity

- Instill awareness of electricity wanting to find a path to the ground
- Create awareness of the dangers of electricity
- Develop effective questioning skills
- Foster a sense of curiosity about electricity
- Create motivation to investigate further
- Provide realization that electricity is flowing through their body
- Learning to discuss problems

Determining the range of behaviours that exist at the exhibit

After establishing learning goals, the behaviours being witnessed at the exhibit should be identified. This can be done through preliminary observations. A list of all behaviours witnessed is essential in determining if they are the intended behaviours of the exhibit and how they could be possibly be altered.

Sample of Existing Behaviours Exhibit about Electricity

- Some visitors approach and read sign then interact
- Some visitors interact then read sign
- Few visitors correctly utilize the tactile exhibit parts
- Most visitors are not in a group
- Some discussion about electricity occurs
- Little discussion of real world applications occurs
- On average visitors spend less than one minute at exhibit

Deciding how the trace will alter behaviours

The list of observed behaviours will be essential in deciding how the success of the trace will be determined. When designing a trace, the ideal visitor experience should be stated.

- How will the trace alter the existing experience?
- What will be the ideal experience?
- What will be the role of the trace?

These intended behaviours will be very important when analyzing the successfulness of the trace.

Sample of Proposed Behaviour Alteration
Current: Little discussion occurs at the exhibit

Alteration: Addition of the trace will increase amounts of discussion about electricity and its real world applications.

Path 2: Non-Exhibit Specific Trace

Determine the role of the trace

The desired role of each trace should be clearly specified.
Is the trace meant to a) inspire creativity b) foster curiosity c) create a sense of community d) increase socialization or e) allow visitors to reflect on their experience?

Establish the desired effects of the trace on visitors' behaviour

After deciding what the roles the trace will have, establish what effects on visitors' behaviour it will have.

- Will it generate discussion about the gallery between visitors?
- Will it inspire visitors to create questions?
- Will the visitor reflect on the experience?

Trace Proposal and Implementation

Presenting the trace proposal

Before figuring out all the design details, obtaining agreement on the trace concept is important. Conversations and meetings at this point are also extremely advantageous as they help to bring up additional considerations and pitfalls. Details of the design (i.e. materials, labeling, placement) can be speculated to help with visualization. This part of the process may take several attempts and possible alternatives might be necessary.

Designing the trace prototype

The details of the design and implementation are now vital. The following are some of the specific things to consider about the prototype as this point.

- Materials
- Labeling and signs
- Spatial issues and placement
- Health and safety

The more people consulted in this process, the more insightful the ideas obtained.

Determining the assessment methods to be used

Before the prototypes go on gallery, methods for assessment have to be determined. These may have been discussed in the process already but at this point need to be finalized. These methods could include observation, interviews, questionnaires, and analysis of visitors' creations or any combinations of the four. Observation sheets and questionnaires should be designed to ensure the most relevant data is to be collected.

Implementing the prototype on gallery

When the prototype is ready to go on gallery, a timetable of testing dates is beneficial for all who are involved. During implementation the dates, times and type of day (particular key stage or weekend date) should be noted. The placement of the exhibit and the trace in the gallery may need to be altered.

Analyzing the trace prototype

In conclusion of implementation, all data must be analyzed. The data must be entered in an organized and easily understandable fashion. Key points can be pulled from the data by keeping in mind the objectives of the trace and exhibit. A set of 5-10 indicators should be used to effectively convey the key points of the data.

Sample Indicators

- Engagement time
- Success (based on goals trace)
- Amount of discussion
- Number of visitor creations

Additional Resources

For more information on trace concepts, the process of creating trace and the results of low-tech trace implementation, please see “The Design and Implementation of Visitor Traces for the Launch Pad Gallery” by Abdullah Azhari, Victoria Briand, Candace O’Connor and Courtney Titone.

The paper “The Power of the Pencil” written by Ben Gammon at the London Science Museum is helpful resource to consult when considering why people are compelled to leave behind comments and read ones left behind.

Recommendations for

Trace

In the New Launch Pad

Abdullah Azhari

Victoria Briand

Candace O'Connor

Courtney Titone

This document is intended to aid the Launch Pad redevelopment team in selecting the types of traces that would be ideal for implementation in the new Launch Pad. Thus it was written with the intent that it will be used specifically by the Launch Pad redevelopment team of the London Science Museum and references concepts and projects that are already understood by the redevelopment team. Should someone outside of the redevelopment team wish to read the following recommendations, it is suggested that they reference The Design and Implementation of Visitor Traces in Launch Pad for further details that will not be addressed in this document.

This document provides suggestions on how trace may be best implemented based off of data from trace concepts tested in the current Launch Pad and trace research. However, the implementation of these trace concepts are not limited to the suggested team's methods. Each trace concept may be implemented within the methods and constraints that the Launch Pad team sees fit.

Catalogue Trace

What is this trace concept?

A catalogue trace has the visitor create a trace so that it may be combined with the traces left by others to be displayed. This display catalogue may then also be used for the benefit and enjoyment of other visitors, even if they choose not to leave behind their own trace.

Why use this trace?

This trace may be easily utilized as a learning enhancement for an exhibit. The act of creating and viewing the trace lengthens the time spent at the exhibit and the amount of content a visitor may cover in that time. If an exhibit has a high level of engagement difficulty, seeing that others have accomplished the goal in the catalogue encourages visitors to continue attempting themselves. The book increases the quality of discussions that visitors had about the exhibit.

The catalogue will show how many visitors interacted and reacted to an exhibit. In showing a few of the various solutions the trace eliminates the common mindset that there is only one solution to a problem and thus inspires creative new solutions from visitors outside of those in the catalogue and encourages visitors to develop more than one solution. This trace teaches the visitor to think outside of the box.

How could it be implemented?

A catalogue trace is valuable to incorporate into a multi-outcome Active Prolonged Engagement (APE) exhibit, such as Hangover Problem. The exhibit needs to have many solutions in order for the catalogue to be effective without too much repetition. Since the trace itself takes a large amount of time to complete, it should work with an exhibit that also requires larger engagement periods.

A catalogue trace may be implemented effectively on a low-tech scale, just as the WPI Trace team did with the River Bridge Book. The method by which visitors record their reactions and results could be as simple as having a notebook by the exhibit in which visitors record their trace. However, it will be more effective if the trace is presented with a higher level of professionalism by having the traces presented to the public in a bound notebook form. The exhibit should have a spot available so that the catalogue may be mounted somewhere noticeable so as not be able to be thrown in an out of sight spot by visitors. Also rather than having the visitors draw images (if there any that are associated with the exhibit) taking a picture of the trace with a digital camera is an effective way to display what other visitors have accomplished.

A high-tech implementation possibility is to have the catalogue be digitalized and displayed on a touch-screen. The process of taking photos of the trace could be unfacilitated if the camera was arranged in a way so that the visitor could hit a button and have the camera take a picture, similar to the system in Shadow Box. However, the camera would have to be arranged in a way so as not to capture the images of the visitors since visitors under the age of

17 need parental permission to be photographed. As it becomes easier for visitors to leave behind their trace without assistance the more need there is for a feedback system to screen out inappropriate responses.

Discussion Trace

What is this trace concept?

Discussion traces have visitors leave responses to thought provoking questions. The questions chosen can vary greatly depending on the developer's learning goals. These responses were then kept on display for the viewing of others.

Why use this trace?

This trace increased visitors' engagement time with the exhibit and provokes them think about the phenomena on display in the exhibit. This trace could also be utilized as a stand-alone trace for almost any topic imaginable. Visitors can learn more by reading what other people think. This trace also allows users to leave their personal touch on the gallery. This trace is also appealing to users because in general, it was found that visitors like to see the personal touch of visitors in the gallery. Since this trace is discussion based it helps the visitor improve their communication skills since they want their opinions to be understood by others.

How could it be implemented?

This trace can easily be utilized as a stand-alone trace. However, it may also be a powerful short engagement (SE) exhibit tool. The nature of SE exhibits sometimes makes it easy for the science behind the exhibit to be overlooked and so a discussion trace is ideal. The trace makes the visitor stop and reflect about the science behind their short but meaningful interaction. Should the trace be implemented as exhibit dependent, its location should be right next to the exhibit.

The question or topic posed by a discussion trace has to be worded carefully, in a way that both appeals to visitors and fulfills the intended learning

goals. In order to create a question that does both it is suggested that the developers prototype several questions before the final implementation.

This trace may be implemented effectively as a low-tech trace. A notebook pad may be used, however, it is better if all of the responses are displayed at eye level on a wall so they may more easily be read. If the responses are written on note cards it is best if they are coloured so they may attract attention. There should also be enough space for a hard surface for writing as well, visitors may not fully write out their response if they have to write under uncomfortable conditions.

A high-tech method for implementation of this trace is to have all of the discussion occur purely through a digitalized database similar to the Tell system. However, should this be the system chosen a sophisticated filtering process would be set up so inappropriate responses are not made available to other visitors. As a result the visitor may never see the trace on display, and what effect this may have on visitor's willingness to participate is unknown.

Community Builder Trace

What is this trace concept?

Visitors leave behind their personal responses or objects, which are typically not related to concepts learned. All of these traces collect until the goal of the trace project is achieved, and it cannot be accomplished without the participation of many visitors. However, some community builders are also made so that the goal of the trace is for visitors to continuously create these traces. The goal for this trace is to make sure visitors continue to participate for as long as possible.

Why use this trace?

This trace enhances communication skills (if it is response based) since the visitor wishes that others may read and understand their trace. Thus the visitor will attempt to write legibly and in complete sentences. It also creates a sense of connection with the gallery and other visitors since the visitors are given

a chance to personalize a small aspect of the gallery. This trace focuses more on this theme of personalization than on emphasizing lessons learned.

How could it be implemented?

This trace typically works well as a stand-alone trace and may be implemented in many creative ways. Some ways to implement a community builder trace in a low-tech fashion are to make a simple mural that may be composed of anything from Post It responses to gobstoppers. A high-tech trace may involve advanced computer databases.

Video Spin Browser

What is this trace concept?

The video spin browser continuously records the activity of a subject; the visitor then may manipulate the flow of time of the video recorded. The subject may be seen as far back as when the recording first began and the visitor may choose the speed at which they wish to scroll through this video data. Other museums have already implemented this system effectively, such as The Ecotarium (as seen in the figure to the right), New York Hall of Science, Boston Museum of Science, New England Aquarium and the National Maritime Museum all have implemented video spin browsers in a museum gallery setting.

Why use this trace?

This trace allows for visitors to see a subject as visitors of the past had once seen it. This creates a sense of connection to the other visitors who have also viewed the trace since as the visitors view the trace their own personal view of the subject is being documented for others in the future to see. The technology that this trace implements is intriguing and also fun to use.

How could it be implemented?

The Video Spin Browser is typically used on a subject in which the activity is very fast paced or slow paced. This way the visitor may speed or slow time accordingly to truly understand the phenomenon that is occurring. The following is a list of examples where Video Spin Browser was used to allow visitors control over the time lapse of a subject/event.

- The rise and fall of tides
- Factory robots working
- A space shuttle launching
- Balloons popping
- A surgical procedure
- The construction of a new museum
- Nuclear blast testing
- Aquatic activity

(TechnoFrolics, 2006)

The video recording system must also be arranged in a way so that visitors cannot be caught on camera. If visitors under the age of 17 were caught on camera and other visitors were able to view them there will potentially be legal difficulties. For details on where to find a video spin browser and pricing please visit the TechnoFrolics Company web site as seen in the references (TechnoFrolics, 2006).

"Cool Stuff" to be taken into Consideration

The following are ideas suggested by the museum staff inspired from other contemporary traces. The team was not able to test these suggestions due to project constraints, however theses ideas are still valuable traces to be taken into consideration.

Scott Snibbe

Scott Snibbe created a trace that was a TV grid with 16 screens; each screen displayed the shadow of a visitor from a different time setting. The first box contained current shadows and all of the subsequent boxes showed the shadows recorded at defined time intervals before the current shadow being recorded. For example the next screen might be 10 minutes behind the 1st screen and the next screen might be showing shadows from 2 weeks before the 1st screen.

This trace could ideally be incorporated into exhibits with a lot of bodily movement such as the Shadow Box exhibit. The shadows created on the light sensitive screen could be recorded and displayed for the visitors just as Snibbe's shadow images were. For more information on the trace work of Scott Snibbe please reference his web site in the references (Snibbe, 2006).

Big Art for Little Artists

Within the Big Art for Little Artists gallery at the Walker Art Gallery visitors are encouraged to make artistic creations that are then put on display in the gallery and also on the gallery web site. In order for such a trace to be implemented the new Launch Pad would need to have enough room for a table for visitors to make their creations at. This type of space is unavailable in the current Launch Pad. For a complete description of the entire gallery and its specific traces see the web site in the references (Walker Gallery, 2006)

LED Throwies

LED throwies are a new electronic graffiti development at Eye Beam in New York. LEDs are attached together and thrown onto a wall, which they stick to and may form patterns for passersby to see. This throwie concept could be used in the New Launch Pad provided that there is enough space for them. For further information and a video on throwies please see the web site in the references (Graffiti Research Lab, 2006)

Additional Resources:

http://www.technofrolics.com/trade-show-exhibits-museum-exhibits/video-spinbrowser/video-spin-museums.html

http://www.snibbe.com/

www.thewalker.org.uk/bigart

http://graffitiresearchlab.com