2011-04-20

# High Priority Design Values Used by Successful Children's Museum Exhibit Developers: A Multiple Case Study Analysis of Expert Opinions

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# HIGH PRIORITY DESIGN VALUES USED BY SUCCESSFUL CHILDREN'S MUSEUM EXHIBIT DEVELOPERS:

# A MULTIPLE CASE STUDY ANALYSIS OF EXPERT OPINIONS

by

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A thesis submitted to the faculty of

Brigham Young University

in partial fulfillment of the requirement for the degree of

Master of Science

Department of Instructional Psychology and Technology

Brigham Young University

April 2011

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## Abstract

The following qualitative study sought to answer three questions: (1) What are the high priority design values used by expert exhibit developers to create meaningful exhibits at children's museums? (2) How do exhibit developers prioritize these design values? (3) What are the desirable outcomes that exhibit developers seek to achieve with the guests who interact with the exhibits? These questions were answered through interviews with children's museum exhibit developers, personal observations, and artifact analysis. The data collected was organized into four cases, each representing a different children's museum and corresponding exhibit developer. The cases were then compared against each other using multiple case study analysis as described by Stake (2006). The data revealed that most of the developers designed exhibits which promoted family learning by encouraging meaningful interactions between parents and children. Other high priority design values used by exhibit developers included physical engagement, multiple entry points, simplicity, durability, multisensory engagement, staff and volunteer facilitation, safety, and immersive environments. Successful museum exhibits empowered guests and were always created using multiple design values. This thesis may be downloaded for free at http://etd.byu.edu.

Keywords: museums, children's museums, family learning, exhibit design, exhibit development, design values, desirable outcomes, physical engagement, immersive environments, multisensory engagement, facilitation

**Acknowledgements**

First and foremost I would like to thank my wonderful wife Erin for continually encouraging me to complete this thesis. I could not have done it without her help. I also wish to thank my committee members for their feedback, particularly Dr. Andrew S. Gibbons. He was willing to spend countless hours with me in his office, at his home, and everywhere else in between as I revised, revised, and revised some more.

Lastly, I wish to thank the Lord. For without Him, I am nothing.

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## Introduction and Problem Statement

In recent years many museums have shifted their focus from being collection and preservation facilities to hands-on discovery centers. Children's museums in particular have embraced this new trend. Guests at these museums are given hands-on opportunities to interact with the museum exhibits and with each other. Families are a primary group that attend children's museums (Astor-Jack, Whaley, Dierking, Perry, & Garibay, 2007); and as a result, for some museums, designing for families has become increasingly important.

The first purpose of this study was to expose the design values that are used by expert exhibit developers to create successful children's museum exhibits. Design values are those ideals which guide the developers in their design; they are the developers' judgment of what is important about each exhibit. In a way, design values are a reflection of a museum and its developers' standards and beliefs. It was assumed that designing for families may be one of these values. It was also assumed that expert exhibit developers may use other design values when developing their exhibits, such as entertainment value, instructional value, and interactivity. Expert developers may use these and other design values to create exhibits targeted to families. These values may intersect with one another, creating exhibits that are meaningful in many dimensions. The values that are discussed later in this document are those that were defined by the exhibit developers themselves.

The second purpose of this study was to see how developers prioritize their design values. For instance, when creating a new exhibit, what is the design value that acts as the driving force for the rest of the exhibit? What are the other design values that are secondary to the central value? Why is one design value a higher priority than another design value? How do differing design values relate to one another and why?

The third purpose of this study was to identify the desirable outcomes developers hope visitors will experience as a consequence of their engagement with the exhibits; these are what result from the visitors' interaction with the exhibits. It is often a change that takes place in a visitor's behaviors, thoughts, or beliefs. Because these desirable outcomes were to be identified and defined by the exhibit developers, it was unknown whether or not they would be easily measurable. It was assumed that developers hoped that an exhibit prolonged engagement, inspired guests, taught or trained, strengthened parent-child relationships, or extended learning after leaving the exhibit (at home, for example). Additionally, connections were made between the design values used by the exhibit developers and the intended desirable outcomes for the visitors. This study examined specific instances of developers using design values to create desirable outcomes for children's museum exhibits. To accomplish this, this study sought to answer the following questions: If an exhibit is supposed to be designed for children and parents, how can it be meaningful for both, and how can one know if it is? What causes some exhibits to be successful and others to fail?

This study pursued these purposes using qualitative methods including interviews, observations, and artifact analysis. Interviews with expert exhibit developers were the primary method of data gathering. Exhibit developers were selected from some of the top children's museums in the United States, according to *Child* magazine and parents.com (Sangiorgio, 2001). All data collected from the developers were compiled into case studies. Each children's museum, along with its corresponding exhibit developers, were placed into individual cases. These cases were compared against one another using multiple case study analysis as described by Stake (2006).

The results of this study may also be used to help in the development of other children's museum exhibits. In particular, they will be used to help develop some exhibits for a new children's museum called The Museum of Natural Curiosity, which will be built at Thanksgiving Point, a museum complex in Lehi, Utah.

## Literature Review

Two bodies of research were relevant to this study: the purpose of museums; and the nature of family learning in museums.

### The Purpose of Museums

According to a study conducted by Educational Facilities Laboratories, museums were originally seen as object keepers (*Hands-On Museums*, 1975). This meant that museums were more concerned with collecting and preserving artifacts and less concerned with providing patrons with opportunities for discovery by interacting with those artifacts or each other. However, during the mid- to late-1900s, there began to be a shift in the focus of some museums, particularly children's or youth museums. The focus shifted from being object-oriented to experience-oriented, meaning the museums sought to provide their guests with opportunities to learn from, and interact with, the artifacts. More emphasis was placed on the experiences and participation of the patrons and less on the preservation of the artifacts. These newer types of museums have become increasingly popular since their introduction. According to this same report, there has also been a shift in the ways that museums have contributed to their communities. They have become known as independent learning centers, which provide additional educational experiences for schools, families, and the community at large.

In recent years experience-oriented museums have created exhibits that have learning objectives that are more closely related to modern learning theories, including constructivism. This allows the museum guest to be more active in the learning process and even grants him or her opportunities to set their own learning objectives and goals. San Francisco's Exploratorium, which is known for its rich hands-on, experience-oriented exhibits, has adopted a new way of designing and developing exhibits. In the past, the Exploratorium developed exhibits that were

known as “planned discovery” exhibits (Humphrey & Gutwill, 2005). This meant that the museum had a specific learning outcome or objective associated with each exhibit, and a museum patron could achieve the learning outcome through planned activities. While this still allowed the museum to be experience-oriented, it led to a more traditional view of museums as authoritative resources in communities. The museum was seen as the source of information, and there was something specific for the patron to learn. Still, planned discovery exhibits did not provide guests with the opportunity to direct their own learning.

During the late 1990s a new trend began to take hold at the Exploratorium. It was called Active Prolonged Engagement (APE) (Humphrey & Gutwill, 2005). Exhibits that were designed with an emphasis in APE were much less authoritarian. In fact, these exhibits encouraged visitors to draw their own conclusions, build their own models, lead their own scientific inquiries, and find out for themselves which scientific principles were represented at each exhibit. The Exploratorium reported that these APE exhibits did in fact encourage more visitor engagement with the exhibits. Instead of telling the visitors what they should know or think, APE exhibits encouraged museum patrons to construct their own knowledge as they interacted with the exhibits.

Pekarik (2010) has also emphasized the importance of keeping exhibits open-ended. When speaking about exhibits that are designed with specific outcomes that should be evaluated he said, “These learning outcome frameworks emphasize the passive acquisition of information and attitudes rather than the active construction of something new and personally meaningful (and perhaps unexpected by the museum)” (p. 108). In order for museums to successfully encourage their visitors to make their own personal discoveries they need to have a mindset change which encourages more learning potential for the visitor. He stated,

> To see the museum as a field of potential for human growth is to see it as a place that serves others…Its task—from this perspective—is to provide a setting that is as rich with opportunities, as alive and intriguing, as is humanly possible. The museum becomes, in a sense, a hyper-reality—a trackless realm to play in…that offers opportunity for engagement in multiple ways, with the capacity to be intense and powerful. (p. 110)

**Family Learning in Children's Museums**

According to recent studies on social groups that attend museums, there are primarily three different types of groups: family groups with varying ages, adult groups, and children groups such as school field trips (Astor-Jack et al., 2007). The authors argued that socially mediated learning can take place between parents and children when exhibits are designed with collaborative learning in mind, meaning the exhibits are meant for both children and adults. This collaborative learning between parents and children is called family learning.

Family learning is facilitated when there is meaningful interaction and discussion between family members. This can happen across generations: children learning from parents and parents learning from children. Grandparents may also play a part in the learning. Family learning does not only involve learning academic subjects such as reading, art, and science. It is also a way for parents to teach their children morals, ethics, civic responsibilities, and is a means to pass on traditions (Ellenbogen, Luke, & Dierking, 2007).

Researchers have noted that family learning has become a greater focus for museums in past decades, particularly in children's museums. While interacting with exhibits, family members can teach one another and draw on past experiences that they have already had together (Ellenbogen et al., 2007). Plus, after the museum visit is over, families can return home and

continue to talk about the meaningful experiences that they shared at the museums (Falk & Dierking, 1992).

Family learning can take on different appearances. Dierking (2011a) recommended looking for the following characteristics when identifying whether or not family learning is occurring:

> Family learning is playful, fun, and a social experience. Family learning is influenced by the ages of the children and adults in the group. Families all learn in different ways. Families find value in their own personal observations and experiences by working, talking, and solving problems together (Introduction section, para. 2-4).

But perhaps the most important thing to look for is conversation says Dierking. A family's conversation between members may be both verbal and nonverbal. In their conversations families will likely talk about the things they are learning at the museum and liken it to past experiences they have already had together. Family learning also occurs when families are participating in the exhibits together.

Museums are seen as ideal places where family learning can occur. Because families are a major audience, museums have become cultural gathering places where family member can experience unique learning experiences together. Dierking (2011b) states, "Museums have an opportunity to play an important role in supporting [families'] lifelong learning in their communities," because they provide families with opportunities to participate in learning together (para. 1). Families are free to chose which exhibits they would like to engage in, the amount of time they would like to spend at each exhibit, and together parents and children can draw their own conclusions that are applicable for their family.

Some studies have been conducted to determine effective design principles used to create family-oriented exhibits. Borun and Dritsas (1997) identified seven characteristics of successful family learning exhibits. An exhibit that focuses on family learning should be multi-sided, multi-user, accessible, multi-outcome, multi-modal, readable, and relevant (Borun & Dritsas, 1997). Their studies showed an increase in engaging interactions between family members when exhibits were built with these design characteristics.

**Conclusion**

Two bodies of literature were examined in this literature review. In the first body of literature, the purpose of museums, it was observed that children's museums have less inclination to be object keepers. Instead they have focused efforts on creating meaningful experiences for their guests by providing hands-on opportunities for discovery. In the second body of literature, family learning in children's museums, it was observed that because families are their primary audience, children's museums seek to provide opportunities for family members to interact with one another in meaningful ways. They seek to engage both children and adults by creating exhibits that are appealing for all age groups. This study contributes both to the object-oriented and family learning literatures and to the limited literature about children's museum exhibit design.

## Method

The following sections will outline the method used in this study, which includes case study methodology, data collection, data analysis, trustworthiness and qualitative standards, role of investigator, limitations, and ethics.

### Case Study Methodology

The intent of this study was to gather opinions from expert exhibit developers from four of the top children's museums in the United States and use the data to formulate case studies. These case studies were compared against each other in a multiple case study analysis as described by Stake (2006). Each case study featured analyses of high priority design values used by exhibit developers.

**Case selection.** The museums selected for this study were taken from a list of top museums according to a survey conducted by Child magazine and parents.com (Sangiorgio, 2001). These museums include The Boston Children's Museum, Children's Museum of Pittsburgh, Children's Museum of Houston, and Science City at Union Station Kansas City. The developers from these museums were invited to discuss the high priority design values they use to develop their exhibits. Each museum, with its corresponding exhibit developer, was treated as an individual case. Qualitative research methods were used to collect the data for each case study, including interviews, observations, and artifact analysis.

The museums sampled for this study were selected based on a blend of purposive and convenience sampling (Merriam, 1998). As noted earlier, the four museums selected are among the top museums in the nation according to *Child* magazine and parents.com. They were also selected because the values and practices of these museums are similar to the values and practices that will be followed in the Museum of Natural Curiosity, meaning these other four

museums focus on providing meaningful experiences for family members of all ages. These four particular museums were also conveniently selected because of the business and personal nature of the trips taken to visit them.

**Case study rationalization.** Case studies as a research methodology were chosen for a number of reasons. First, case studies can provide a deep understanding of a particular experience or phenomenon. In this study, cases provide rich details about successful exhibits in an attempt to help readers feel like they are experiencing what the exhibit developers designed. This objective is quite different than the generalizability that quantitative studies often try to achieve. Instead these cases of museum developers and their exhibits hopefully provide meaningful insights about each particular museum, thus allowing the readers to make their own interpretations based on their own experiences. Through rich descriptions readers will hopefully be able to identify how the general design values used by the exhibit developers were applied in specific contexts.

A second reason for selecting case studies as a research methodology was that each museum and its developer had enough unique characteristics and insights that each merited their own case. For example, one case is the Boston Children's Museum and one of its developers; another is the Children's Museum of Pittsburgh and one its developers; and so forth. Each museum has its own character, approach to development, branding, ideas, strengths, and weaknesses that are best understood through thick descriptions in individual case studies. Within each museum case resides descriptions of specific museum exhibits. Discussing each museum in its own case allows the readers to understand each museum separately.

After individual cases were analyzed, multiple case study analysis was used to compare and contrast them, as will be explained in the data analysis section (Stake, 2006). As the author I

offered my own conclusions and insights as the multiple cases were compared, but hopefully provided enough description in each case to allow readers to make their own interpretations based on what they have read and observed.

**Data Collection**

In order to discover the high priority design values used by successful children's museum exhibit developers, telephone interviews were conducted with one exhibit developer from three of the four museums. One of the exhibit developers was unable to unable to be interviewed over the telephone; he was interviewed asynchronously via email. These interviews were supplemented by informal observations and by artifact analysis.

**Interviews.** At each of the museums selected, an exhibit developer was interviewed. These interviews provided a majority of the data for this study, because the primary research questions sought to know what developers think makes a successful children's museum exhibit. The research proposal called for selecting developers on the basis of several characteristics, including prior work experience at high profile museums, recognitions received for prior exhibit development, special academic or technical preparation, and publications on exhibit design. However, when conducting the study, whichever developers responded to inquiries to become research subjects were interviewed. Fortunately each developer from the four museums has experiences developing popular and successful exhibits for their museum; however, the work experiences also vary between developers.

Exhibit developers who participated in the telephone interviews were prepared prior to their interviews with information about the general questions that would be asked. The interviews were audio recorded. The telephone interviews lasted between 30 and 50 minutes. One of the developers participated in the study by answering the interview questions by text over

email. No follow-up interviews were conducted with any of the developers. All interviews were transcribed.

Semi-structured interviews (Merriam, 1998) were conducted with each telephone interviewee (see the appendix for the interview protocol). Semi-structured interviews allowed the interviewer to have specific questions that he wanted answered, but it also allowed him to deviate and be flexible when asking the questions. The interviewee who answered the interview questions over email answered the questions that were on the interview protocol. Questions on the protocol include those like the following: (a) What design values do you use when you design and develop children's museum exhibits for your museum? (b) How would you prioritize your design values? (c) How do you create an exhibit that engages both children and parents in learning activities and has an element of fun? (d) What factors contribute to making a successful children's museum exhibit? (e) What is your favorite exhibit and why? (f) What is the most popular exhibit and why? (g) When you develop new exhibits, what desirable outcomes do you strive to achieve with the guests?

I deviated slightly from some of my set questions in an attempt to allow the developers to explain what makes a successful children's museum exhibit. Conducting semi-structured interviews allowed for deeper insights that would not have been available through the use of structured interviews. This will be made apparent later in the study when comparing the three telephone interviews with the asynchronous interview.

**Observations.** Because preliminary visits were made to each of the four museums, the telephone interviews with expert children's museum exhibit developers were supplemented with personal informal observations. While at these museums I conducted informal observations of museum patrons interacting with the museums' exhibits. I also interacted with the exhibits.

These observations provided insight that guided the interview questions. The observations supplemented the interviews and provide the reader with more narrative and context.

When visiting each museum, observations were primarily directed at families who were interacting with the exhibits. However, because of the business and personal nature of the trips taken to visit these museums, only a limited amount of time was spent conducting observations. During these informal observations I took on the role of an observer as a participant by interacting with the exhibits myself (Merriam, 1998). These personal observations helped formulate the assumptions about successful children's museum exhibits I listed in the introduction. The final write-up includes both specific things that were observed along with personal reflective comments based on what was experienced. Due to the nature of the research, I was unable to return to these museums to conduct further observations.

**Artifact analysis.** It was set forth in the proposal to conduct both document and artifact analysis. However, no design documents, research papers, or museum statistics were acquired; therefore, only artifact analysis was conducted. Treating the exhibits as artifacts was particularly important to the study, because they were the primary objects of analysis. The exhibits were described in detail as a part of the study. Understanding what the exhibits look like, how they work, and how they are used provides additional insight for the readers. Exhibit components such as interactivity, hands-on manipulation, educational objectives, technology, and appearance were analyzed in this study.

Photographs were taken of the exhibits during the preliminary visits to the museums, and many of these pictures are included in this study. Including pictures of the exhibits allows the reader to see the exhibits that are being referred to. Additionally, these photographs provide the needed explanation about the exhibits to the readers that words cannot.

**Summary of data collection.** A holistic understanding of the high priority design priorities used by expert exhibit developers was examined using the combination of qualitative research methods, including interviews, observations, and artifact analysis. Merriam explains, "In contrast to quantitative research, which takes apart a phenomenon to examine component parts…qualitative research can reveal how all the parts work together to form a whole. It is assumed that meaning is embedded in people's experiences" (Merriam, 1998, p. 6). Each case study includes a narrative of what was experienced with the goal to provide the reader with the opportunity to make his or her own conclusions. The results of the data may be used to help the staff at Thanksgiving Point and the Museum of Natural Curiosity to produce a children's museum with exemplary exhibits for families.

## Data Analysis

The data collected for the case studies was analyzed using three methods: constant comparison (Merriam, 1998, p. 159); category construction and analysis (Merriam, 1998, p. 179); and multiple case study analysis (Stake, 2006). The following paragraphs will outline the methods and procedures that were used to analyze the data.

**Constant comparison.** Constant comparison was used throughout the entire data collection and analysis portions of the study. With constant comparison, new data is compared against old data that has already been collected. The result is that comparisons and contrasts can be made between the two sets of data. Merriam further explains, "These comparisons lead to tentative categories that are then compared to each other and to other instances. Comparisons are constantly made within and between levels of conceptualization until a theory can be formulated" (Merriam, 1998, p. 159).

Data was collected during a pilot study from some children's museums through observations. When the interviews were conducted, the results of the interviews were compared against the findings of the observations. Then, as conclusions were drawn, further interviews were conducted to confirm or reject the findings. Interview questions evolved as more data was collected and analyzed. With constant comparison, the data was always compared against itself as the research study progressed.

**Category construction and analysis.** As the data was collected and constantly compared against itself, different categories of information emerged. Merriam explains, "Devising categories is largely an intuitive process, but it is also systematic and informed by the study's purpose, the investigator's orientation and knowledge, and the meanings made explicit by the participants themselves" (1998, p. 179). The categories allow the researcher and reader to begin to make sense of the information that is gathered.

Merriam further explains, "Category construction begins with reading the first interview transcript, the first set of field notes, the first document collected in the study" (p. 181). When the data was collected for this study, it was sorted into a number of different categories and subcategories based on similarities and differences. After each interview the dialogue from the interviewee and interviewer was transcribed. Common themes and ideas were then identified by coding the interview. Those themes and ideas were placed into categories. Then as other interviews were conducted or other observations made, the new data was either sorted into the original categories or new ones were created. The names of the categories came from the researcher, the participants, or from the literature.

The categories sought to achieve the following characteristics: (a) they are exhaustive, meaning any piece of data could be placed in one of the categories; (b) they are mutually

inclusive, meaning data can only be sorted in one category; (c) they are sensitizing, meaning the category name will give the reader the sense of what is in that particular category; and (d) they are conceptually congruent, meaning the categories will be aligned at the correct levels (p. 184). However, as the research was performed it was noticed that some of the data collected was unrelated to the study. This data was not placed into any categories; for that reason the categories were not completely exhaustive. Also, as exhibits were analyzed it was observed that some of the data was not mutually exclusive; there were aspects about the exhibits that could go in multiple categories. The category construction was adapted to meet the needs of this study. The other qualifications for the categories were met.

The system for managing the data and placing it into its corresponding categories was going to be accomplished using a computer with word processing and qualitative data management software. Instead hard copies of interview transcripts were marked up and coded as categories were formed.

**Multiple case study analysis.** Individual cases were written for each of the museums and their corresponding exhibit developers. Cases were then compared against one another. Multiple case study analysis was used to find similarities and differences between each of the cases. I took "evidence from the case studies to show how uniformity or disparity characterize[d] the" high priority design values used by expert exhibit developers from the different museums (Stake, 2006, p. 40). It was during this stage of analysis that I described patterns that I observed. These patterns can be used as models to inform future design decisions.

## Trustworthiness and Qualitative Standards

The following section outlines the trustworthiness and qualitative standards that were followed in this study.

**Credibility.** It was essential to produce a credible document that portrays research that was done appropriately. On explaining credibility in qualitative research, Williams states that "credibility standard requires a naturalistic study to be believable to critical readers and to be approved by the persons who provided the information gathered during the study" (Williams, n.d.). To maintain the credibility of the research, the following methods were used: triangulation, peer debriefing, and progressive subjectivity checks through the use of field notes.

***Triangulation.*** Whenever a museum developer was interviewed, the results from the interview were compared against the observations that were already conducted. Also, the more people that were interviewed, the more new interviewees confirmed or rejected what was already learned. Personal observations, interviews, and artifact analysis were reviewed against literature that has been written on the subject of developing children's museum exhibits.

***Peer debriefing.*** Peer debriefing came from visiting with university professors in the Instructional Psychology and Technology Department at Brigham Young University. While the professors that were consulted may not have expertise in museum education, they are experts in instructional design, qualitative research methods, and educational science. They ensured best practices were followed to produce accurate and credible results.

***Field notes.*** Documentation of the progress of the study was recorded through the use of field notes. Periodic subjectivity checks were conducted using the interview logs and artifact comments found in the field notes. These subjectivity checks helped identify trends in the research findings, and hopefully helped prevent biases. The field notes also include relevant researcher comments and insights.

**Transferability.** The objective of the final write-up is to provide transferability to the reader. Transferability in data analysis refers to using "clear descriptions of the time and context

in which working hypotheses are developed by the naturalistic inquirer" (Williams, n.d.). In other words, detailed descriptions of what was observed and recorded will provide the reader with as much rich description as possible. Much of this comes in the form of a narrative. Rich descriptions allow the reader to transfer what they read into their own contexts and experiences. Information gathered in the interviews, observations, and artifact analysis were used to paint a picture of what was experienced. Ideally the reader will be able to make his or her own conclusions about the study. This is different than generalizability that many research studies strive for. The purpose of this study was not to generalize the values that will affect children's museums exhibits everywhere. Instead, rich descriptions were written about the design values that are used in specific contexts. These design values are best understood when they are discussed in relation to the actual exhibit in which they were incorporated.

**Confirmability and dependability.** If this research study is to align with qualitative research standards then it needs to be confirmable and dependable. The validity of the report is confirmed through the use of a literature review and an audit trail. The literature review shows how the study fits within the bodies of relevant research. An informal audit trail was created to show how and when the researched was conducted. The audit trail describes how decisions were made by the researcher. Williams confirms the importance of an audit trail when he states, "If such an audit [trail] attests to the confirmability of the study, it is more likely to be accepted by readers" (Williams, n.d.).

To determine if the research is dependable, "one looks to see if the researcher has been careless or made mistakes in conceptualizing the study, collecting the data, interpreting the findings and reporting results" (Williams, n.d.). To maintain dependability, the methodologies outlined earlier in this paper were followed.

## Considerations in Conducting Qualitative Research

Qualitative studies require that the researcher is upfront and open about additional factors that influence the collection and analysis of data, such as the role of the investigator, limitations, and ethics. These will be discussed in the following paragraphs.

**Role of investigator.** As the investigator in this research project, I was the primary instrument for data collection and analysis. There are some inherent advantages and disadvantages with this method of research. Advantages include the following: (a) the researcher is able to draw his own conclusions based on the interviews conducted, observations made, and documents and artifacts analyzed; (b) the researcher is able to make adjustments to the research as he sees necessary, which is a vital part of qualitative research; (c) the researcher is able to pinpoint the parts of the research that he deems to be most important; (d) a holistic picture of the phenomenon can be painted as it is seen by the researcher; and (e) the analysis of this phenomenon will be better understood when there is more than just a comparison between abstract variables and principles. These are real experiences that are best understood from the viewpoint of real people, the developers and researcher. Concerning the investigator as the primary instrument, Merriam states that the investigator "can respond to the situation by maximizing opportunities for collecting and producing meaningful information" (Merriam, 1998, p. 20).

The disadvantages of using the investigator as the primary instrument for data collection and analysis include the following: (a) it is impossible for the researcher to eliminate all biases; (b) the researcher may inadvertently omit important data or interpret it incorrectly; and (c) there is no set, established format that must be followed to produce meaningful results. To prevent the

downsides listed, I followed qualitative research best practices and methodologies outlined in the previous section and will adhere to qualitative standards that will now be outlined.

**Limitations.** There were limitations associated with this study. Time restraint was the first limitation. Since this research is for a master's thesis, there was a limited amount of time allotted to gathering and analyzing the data. The research was also limited by the types of data that were collected. Interviews were the primary source of information and were supplemented by a constrained amount of observations and artifact analysis. If more time were spent conducting observations, for example, more personal insights could have been drawn about each exhibit.

**Ethics.** I pledge that I complied with ethical standards in all aspects of the research. First, in the conclusions that were drawn, special attention was paid to make sure they were based on the original research that was performed. Also, all quotations from the relevant research were cited properly, and credit for ideas was given to interviewees. All forms of plagiarism were avoided. Second, a proposal for an Institutional Review Board (IRB) in the David O. McKay School of Education at Brigham Young University was composed, accepted and has been closely followed. By complying with the requirements set forth there, I used informed consent as museum developers were interviewed. All other codes of ethics were upheld as the research was performed.

## Case Study Results

The purpose of this report is threefold: to identify the design values used by expert exhibit developers to create children's museum exhibits, to see how developers prioritize these values, and to connect these values to the developers' desirable outcomes for the visitors. In this section these values and outcomes will be exposed, defined by the exhibit developers, and analyzed in the following four case study reports. These case studies represent developer comments as well as my personal observations (see appendix for interview protocol). Individual exhibits in the museum will be analyzed as artifacts, and photographs of those exhibits will be included where applicable, allowing the reader to make further interpretations. The design values will be discussed in context as individual exhibits are described.

### The Boston Children's Museum

The Boston Children's Museum has been around in one form or another since 1913. They have championed children and families' engagement in "imagination, curiosity, investigation, innovation, and play" (Boston Children's Museum About Us web page, 2011). Ben Durrell, one of the museum's exhibit developers, has worked with the museum for about six years. His official title is Exhibit Designer, Production Manager. Prior to working for the Boston Children's Museum he worked for a furniture design company, Durrell led a conceptual design group, and graduated from the Savannah College of Art and Design with a degree in industrial design and furniture design. About design, he says "it's really an all hands on deck approach," meaning he is just one part of a much larger museum design team.

**Design values.** The following sections highlight the design values used by Durrell when designing exhibits for the Boston Children's Museum.

***Focus on family learning.*** Durrell's initial comment about the design values he followed was that "Family learning is key." There needs to be "some heavy engagement between the child and their parent." The value of family learning was discussed when Durrell spoke about his first project at the Boston Children's Museum, which is called Johnny's Workbench (see Figure 1).

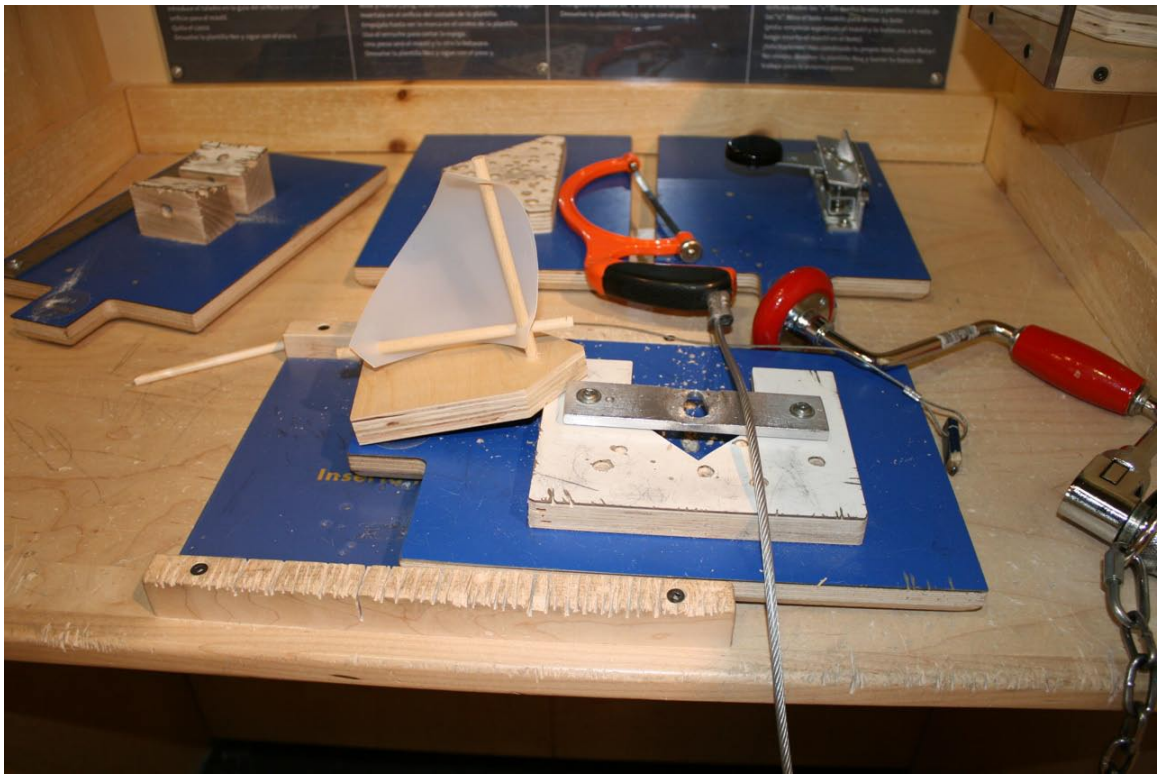

*Figure 1.* Johnny's Workbench with a completed Sailboat at the Boston Children's Museum.

Johnny's Workbench was designed with family learning as a central value. It is designed to be challenging enough that a young child is not able to do it by himself or herself. Help from a parent is needed. Additionally, the exhibit provides families with opportunities to talk about the history of Boston and their own family history. Guests receive a take away object that allows for family learning to continue at home after the museum experience.

At first glance the Johnny's Workbench exhibit looks like a mini workshop. On small cabinet countertops placed throughout this corner of the museum visitors will likely find pockmarked blocks of wood attached to the tabletops. The holes in the wood come from the

hand-cranked drills that lie nearby. Other safe and kid-friendly tools are close-at-hand too. With this exhibit families are able to work together with real tools to create something meaningful. Even the children, with a little adult supervision, are able to create something special.

Across from the test block is where most family interaction takes place. Here there are three or four stations, each of them identical, thus allowing for several museum guests to interact with the same exhibit at once. At each station resides a few modular templates. Simple instructions with steps 1, 2, 3, and 4 are also available, but by the graphics around the little cubbies, it is evident that guests are supposed to build their own sailboat.

It should be noted that the Boston Children's Museum is built on a wharf. Guests can look out the windows of the building and see the waters of the Massachusetts Bay. Boston with its vast harbor is known for its boating and sailing. On a clear day numberless boats can be seen across the harbor. The children's museum intentionally chose for the children to build sailboats; perhaps this was a way to instill in the children an appreciation for Boston's seafaring heritage, thus strengthening the appeal of this exhibit. This connection to Bostonian history provides another opportunity for parents and children to meaningfully communicate with one another. Parents are able to talk about the rich history of Boston, and, where applicable, tie in personal family histories. A sense of place is important for this exhibit in promoting family conversations that lead to learning.

Next to the workstations are several stacked bins with precut blocks of wood in the shapes of ship hulls, sail pieces made out of plastic, and small balsa wood dowels. Each station is equipped with a hand-crank drill, a junior hacksaw, a hole punch, and a brush for cleanup. Using these materials and tools, children drill a hole in the hull for the attachment of the mast,

measure and cut the mast and boom from balsa wood, and insert the dowel pieces into the holes pierced in the sail. After final assembly the visitors get to take their sailboat home with them.

According to Durrell, a child younger than about eight "will have a hard time going through that sailboat making process by themselves without…having a parent in proximity, either offering encouragement or advice, or pointing out they might slow down." Because of the challenging and compelling nature of the exhibit, "it force[s] that interaction" between the parents and the children.

Not every child will seek the help from his or her parents. But most do. Interestingly, Durrell says that "sometimes parents [will] take over and build the boat themselves." This is generally not the case. This exhibit exemplifies family learning, because of the "heavy engagement between the child and their parent," which Durrell thinks is pivotal. "The more interaction that you can see between parents and their kids at the museum the better."

At the end of the experience visitors are allowed to take their sailboats home with them. This serves several purposes. First, if the child was unable to complete the sailboat at the museum, he or she will be able to complete it at home. Once again, this will likely require the help from a parent. Thus it promotes family learning and engagement at home. Also, the families can make additional alterations to the sailboat such as painting it. Second, this tangible object, whenever seen at home, will act as a reminder for the experiences that the family had together at the Boston Children's Museum. Hopefully it will elicit positive memories and will perhaps spark conversations about meaningful times had together at the museum.

In this example, it was shown that Johnny's Workbench is an exhibit that exemplifies the value of family learning. According to Durrell, family learning was the core value of its design. Parents and children can work together to create a tangible model sailboat that they can take

home with them. The exhibit encourages conversation and working together to accomplish a task. Unfortunately, due to sustainability difficulties, Johnny's Workbench no longer exists in its original form. The sailboat building activity has been discontinued. The space is now being prototyped with "alternative activities that are a little easier to maintain."

***Design for physical engagement.*** Other exhibits spread throughout the museum will get children moving, touching, and experimenting. Durrell calls it "physical engagement." He explains, "I think kids moving their bodies around really helps center and focus, and gives them a sense of who they are and where they are on their spaces. So that is my personal goal" when developing exhibits. Formerly, most museums restricted guests from touching their artifacts. However, more recently, children's museums in particular, have changed from "viewing to touching, from seeing to doing," from observing to exploring. The Science Playground exhibition area provides guests with three exhibits that encourage physical engagement. This section of the case study will feature two of those three exhibits, Bubbles and Raceways.

Nowhere in the Boston Children's Museum are there more things to touch than at the Bubbles exhibit (see Figure 2). "Bubbles are so snazzy, and awesome, and infinite, and that's just really exciting for kids and parents…I see a lot of interaction [between parents and children] there." In the Bubbles room there are several table-like sinks filled with bubble solution. Bubble-making props are available throughout the room. Colorful 24-inch diameter rings are interspersed throughout the sinks that are used to make large bubbles; some sinks have differing sizes of PVC pipe that can be used to blow various sizes of bubbles. On one side of a room is a round platform that is surrounded by a moat of bubble solution. In the moat is a hula-hoop-sized ring that is attached to an overhead pulley system. Guests can stand on the platform, pull on a rope that is connected to the pulley, and hoist the hula-hoop over them, thus engulfing

themselves in a giant bubble. Waterproof aprons are available for the guests who want to get fully engaged without getting fully wet. The limited signage throughout the room encourages children and parents to question, play, and notice. Durrell labels Bubbles as one of the most popular exhibits in the entire museum, perhaps because of the amount of physical engagement guests participate in.


*Figure 2.* The Bubbles exhibit at the Boston Children's Museum.

The Bubbles exhibit is next to Raceways. Raceways is a physics playground, created especially for children. Everything in the room is about motion. Off to one wall is what looks like a large up and down rollercoaster made specially for golf balls. Each succeeding hill is just short enough for the golf ball to top it and start rolling down the next slope. Other golf ball tracks can be found throughout the room. One of the tracks looks like a miniature ski jump (see Figure 3). At this one, visitors can release the ball anywhere along the slope to see if they can make the ball jump into any one of several target pipes. The higher children place the ball, the


*Figure 3.* A golf ball ramp at the Raceways exhibit at the Boston Children's Museum.

farther the ball will travel through the air. Children and parents can also build their own golf ball run on the large magnet wall. Durrell says that the room is popular and that "there is a lot of physical activity going on in there." While all of this sounds fun, for some reason "I don't see as much parent-child interaction" says Durrell.

Physical engagement does not necessarily detract from family learning. On the contrary, Durrell explained, "Family learning works best when objects are being moved and manipulated, and there is something tangible in front of you." If a parent can be physically engaged in an activity, then he or she will be more likely to interact with the child. It is interesting to note that while both Bubbles and Raceways feature large amounts of physical engagement, including the manipulation of tangible objects, Durrell observes more family interaction at Bubbles than at Raceways.

***Enhance inquiry through facilitation.*** The third of the Science Playground exhibits is called Investigate (see Figure 4). This exhibit does not emphasize physical engagement like its companions Bubbles and Raceways; but it is compelling for other reasons. At Investigate, children get a chance to practice science in a very inviting way. They are continually engaged in the scientific inquiry process, even if they do not realize it. They can try experiments out one way, then another, then another, until they get it right. Throughout this area visitors will see signs that read notice, observe, wonder, question, measure, discuss, and play. Here visitors can investigate the natural world that is all around them. They can gaze upwards as they lie on their backs underneath a large, transparent turtle tank. Or they can study a snake or another creature that is resting in a cage. But the thing that makes Investigate so successful according to Durrell, "is because it's often staffed." Here meaningful facilitation from staff members or volunteers can be seen. In the middle of the room is a horseshoe shaped table. An educator often sits in the

middle of that table. Here, he or she will engage guests in conversation or perhaps help them complete an interesting project.

> When you can get somebody [from the museum] in an exhibit space, interacting…with the kids and asking questions and creating dialogue, that's amazing! I mean that's just, that's like, in my opinion that's like the, that's the most, that's awesome! (He struggles to find a sufficient way to express his like for facilitation.) I love that. That really makes me really happy.

*Figure 4.* The Investigate exhibit at the Boston Children's Museum.

Because facilitators are so important for the Boston Children's Museum, Durrell designs his exhibits with them in mind. "A priority right now…is [asking,] 'How are the educators and our floor staff going to interact with this exhibit?...How is it serving the people who work on the floors and how is it helping them do their job?'." The facilitator who understands the subject matter, engages guests in meaningful conversations, and encourages guests forward in their own learning really is a priceless asset to the museum. The importance of facilitators, in Durrell's words, is "kind of a no-brainer."

***Create immersive environments.*** Durrell's favorite exhibit is the new Peep's World exhibit. Unfortunately this exhibit had not been built when I visited the museum. Therefore, most of the descriptions will come from Durrell. Peep's World is an exhibit space that is based on Boston's WGBH's children's show *Peep and the Big Wide World*. Here children and parents can venture into a part of the museum that looks like Peep's world, and can have learning experiences as they play with light and shadows, sand, and water. The room's environment, in this area of the museum, is intentionally themed and rich in detail. The intent is to have guests get immersed in the environment, therefore getting immersed in the learning experiences. An "immersive environment" is one in which guests forget they are in the museum, per se. Their surroundings help them get more involved in exploration with the exhibits and other members of their group. Immersive environments facilitate learning and help to build cohesiveness among separate exhibits. According to Durrell, an immersive environment creates a narrative for the visitors to follow:

> The story [must be] simple and clear. Then 95% of the visitors can grasp it immediately and there's no question as to what they're doing in that room. And there's no question why they should be touching this or moving this or thinking about this, it's part of their mission. They walk and immediately they are game for the experience…That's so key.

According to Durrell, an immersive environment can also help accomplish the goal to facilitate family learning. As a result the Peep's World exhibit is another exhibit that champions family learning. When asked how family learning was achieved with Peep's World, Durrell stated,

> I think one way to do it is to have immersive environments, [meaning] when environments are really well done. And they don't have to be realistic and there are different ways of doing it, but when the environment itself is immersive I think people switch gears a little bit and it helps facilitate [family learning].

In part of Peep's World guests are immersed into the Deep Dark Woods where they can create interesting shadows using LED lights. Nearby, parents will see signage that encourages them to interact with their children. Often a sign will simply prompt a parent to ask their child a specific question. There is a lot of parent-child interaction that takes place here. Durrell is not quite sure why. It could be due to the signage, but similar types of signage are available throughout other parts of the museum:

> There are some signs that ask that the parents…to choose questions…to ask the kids. When you see the parent just glancing at it – it only takes them two seconds – they read it and then immediately ask their child the question about it. Then they're off and running, and it really works. But then again I've also seen that not work in other exhibits. I've seen parents ignore signage. So like I said, I don't know what the magic formula is, but sometimes it really works well. And Peep in the Big Wide World, it works like magic in that exhibit and it's awesome. It's a great exhibit.

Parent and child participation is one of the primary byproducts of this themed area. It is possible that parents feel more willing to engage in meaningful conversations and activities with their children at the Peep's World exhibit, because they feel so immersed in this inviting, discovery-oriented environment.

**Prioritization of design values.** Throughout the interview Durrell highlighted several design values that he uses when designing exhibits for the Boston Children's Museum. Some of

those values included family learning, physical engagement, staff facilitation, and immersive environments. When asked if one was more important than the other values, he responded with the following:

> No, but I think that they go hand-in-hand. I think you can't focus…on one and say this is going to be our priority for this exhibit or this component. I think you have to understand how they work and how they're going to work together. Because they should just enhance and inform each other…You just have to hit it right so it's doing its job.

Above Durrell underscores that the values emphasized depends on the objectives of the exhibit being designed. This is actually decided long before the visitors see and experience the exhibit. Durrell works with a team of other designers and developers. Together they decide "what needs to be in the exhibit, who is the exhibit going to serve, and what's the best way to make that happen?" While there still is a prioritizing of design values taking place, it is done on an exhibit-by-exhibit basis by the entire team of developers.

**Desirable outcomes.** The following are desirable outcomes that Durrell seeks to achieve when he design exhibits at the Boston Children's Museum. These outcomes focus primarily on the visitors and not on the exhibits themselves.

***Empower participants.*** "I want kids to…walk out of our museum feeling empowered." That is Durrell's primary desirable outcome. Empowerment can come from a number of different activities at the museum. As was discussed earlier about Johnny's Workbench, many of the activities at the museum are challenging for children. Children can feel a sense of accomplishment when they complete a difficult task.

One particular exhibit may initially seem very frightening for some children. This is the museum's New Balance Climb exhibit (see Figure 5). The climber rises through the museum's

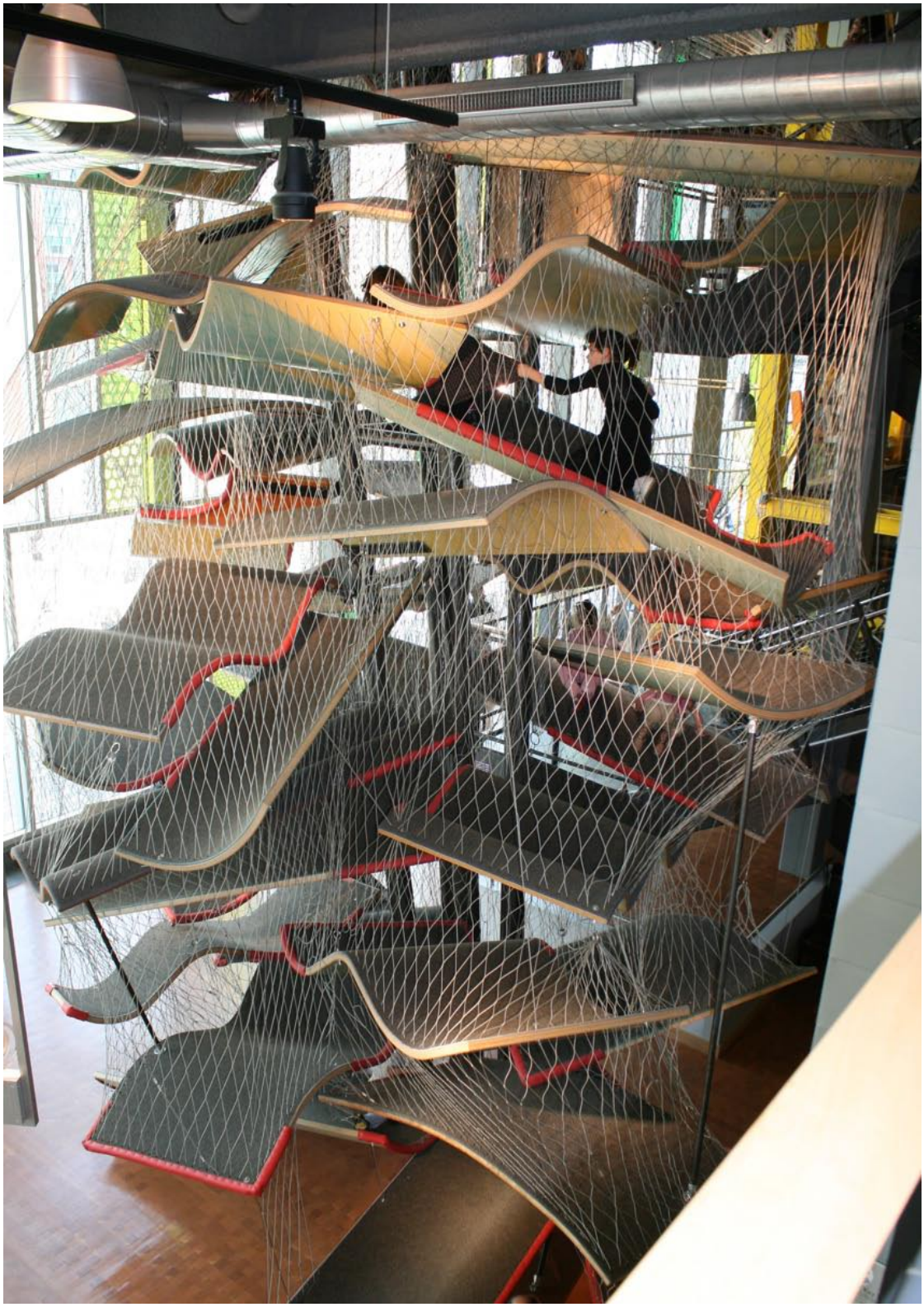

*Figure 5.* The New Balance Climb exhibit at the Boston Children's Museum.

open atrium three stories. It consists of many small wavy platforms that have been connected by strong cables. Children are encouraged to climb from platform to platform, either up or down. Parents can join them or watch from a nearby staircase. Children likely overcome fears when they scale the entire structure for the first time. "Yeah, it's just awesome!" says Durrell. These sorts of experiences teach children that they can do hard things.

***Stimulate family interaction.*** When an exhibit is designed with family leaning as a central component, it is reasonable that a desirable outcome would be meaningful family interaction. Durrell calls it "a beautiful, beautiful thing to watch." This can be observed when "parents and children are interacting in learning." This interaction is often seen as the parents and children have fun together. They are playing, conversing, and learning together. Durrell describes the interaction as something that is more than viewable. He says,

> You can smell [it], you can feel it, you can see it, you can hear it when it's a positive experience. And the kids aren't getting wound up in a way that's going to make their experience…yucky and their parents' experience yucky.

A successful visit for a family at the Boston Children's Museum may mean that they go home tired. Durrell makes a distinction between two different types of exhaustion. He says, "I want kids to walk out of the museum tired, but not because they ran around doing nothing…or banging on stuff all day…[but] because they've really been thinking, and they've been doing, and they've been making, and they've been interacting. The other type of exhaustion comes through confusion and over stimulation. He likens it to returning home from work. The first form of exhaustion comes after working hard and getting much accomplished; the second comes from being distracted from one thing to the next throughout the day. His hope is that they can

get people to feel tired at the end of their museum experience, but in a way that invites them to come again.

***Focus on open- and close-ended outcomes.*** Each of the exhibits at the Boston Children's Museum has a different set of outcomes. Some of those outcomes are fixed, or close-ended. This means each visitor will experience, participate in, or create the same thing. Such is the case with Johnny's Workbench. Each guest is invited to build the same type of sailboat. The step-by-step instructions are the same for every visitor. When the steps are followed the results are always the same. Contrarily, some of the exhibits have open-ended outcomes. The Bubbles exhibit is an example of free play where every outcome is different. The way that guests are invited to interact with the exhibit is open. Every bubble is different. The results for each guest are different.

Whether an exhibit is designed to be open- or close-ended depends upon the exhibit. When designing Johnny's Workbench, Durrell intentionally created it to be close-ended. He said, "It was my gut instinct to have one thing that the kids would build and to not have it open-ended…When a child is using a tool…[or] when they are learning a skill [they] should have a desired outcome.". Durrell further explained that while this exhibit limited the creativity of the children, it did not prevent them from having meaningful experiences:

> You're learning how to pull a [saw] blade…through a piece of wood. You're not expressing creativity. That wasn't the intent of the interactive. So in that case [Johnny's Workbench] was definitely not open-ended. It was a, "This is what you do..." You saw it; that's the sailboat. All the sailboats almost look identical. And that didn't change the smiles on the faces of the kids as they walked out of the exhibit.

Durrell further explained that if he were to pick between designing towards open- or close-ended outcomes, he would likely choose close-ended. This is primarily the case, because "the parent has an example to point to. And then that gets a parent and a child on the same track right away and that's what they are going for." When parents and children can connect together in meaningful ways it accomplishes one of Durrell's primary design values: family learning. In other parts of the museum it was observed that free play is encouraged, which can also get parents involved in learning experiences with their children. It is likely that an exhibit could be open- or close-ended and still achieve the other desired outcomes that Durrell and other museum staff have for the visitors.

**Conclusion.** This Boston Children's Museum case study has highlighted the primary design values used by Ben Durrell, one of its exhibit developers. These values include family learning, physical engagement, inquiry, staff facilitation, and immersive environments. The preceding sections have defined those values in the context of specific exhibits at the museum. The following paragraphs are other assertions that can be made about the design values used by Durrell.

It is difficult to isolate individual design values; meaning they are, for the most part, interrelated. For example, according to Durrell, Johnny's Workbench was designed with family learning as a central value. However, the exhibit also features physical engagement. While the exhibit is meant to get families to cooperate as they build the sailboat, it is impossible to build it without physically building it. Likewise with the giant climber in the atrium, children are not just challenged physically. There is an element of emotional challenge as well, being able to overcome one's fears. Often focusing on one design value helps to accomplish another design

value, such as emphasizing physical engagement to get families to interact and learn together. Interrelated design values leads to the next assertion.

Exhibits are successful for different reasons. Some are hands-on, some are facilitated by volunteers or staff members, some are open-ended, and some are close-ended. Again a comparison can be made between Johnny's Workbench and Bubbles. They differ in their outcomes. Johnny's Workbench has a set activity, which if repeated will obtain the same results each time. The Bubbles activities are so diverse that it is almost impossible to achieve the same results time after time. This difference does not make one exhibit better than the other. Instead the various values can be used to create exhibits that are diverse and applicable for a larger audience. Hence the final point discussed in the next paragraph.

The museum's exhibits are diverse, thus being enjoyable for a large, diversified audience. However, the exhibits are not so eclectic that there is no uniformity throughout the museum. Variety in this museum works to its benefit. While there is variation between exhibits there is an underlying theme that is inviting for children and parents alike. Both groups are invited to participate with the exhibits in ways that are safe, enjoyable, educational, and memorable.

In this case study a few of the design values used by Durrell and exhibits that exist in the Boston Children's Museum have been discussed. There are many other exhibits worth exploring. Those featured in this case were selected because they seemed to fit best with the values that were used by Durrell. Additional works could be written about other exhibits throughout the museum and their unique qualities, including getting the perspective of other exhibit developers.

**The Children's Museum of Pittsburgh**

The Children's Museum of Pittsburgh has been housed in Pittsburgh's Old Post Office building since 1983. The museum "provides innovative museum experiences that inspire joy, creativity and curiosity…[and provides] the highest quality exhibits and programs for learning and play" (Children's Museum of Pittsburgh About the Museum web page, 2011). Anne Fullenkamp is an exhibit designer at the Children's Museum of Pittsburgh and has worked there about three and a half years. Prior to her work there she was an architect for approximately ten years. She first started working at the children's museum as an architecture project manager for a traveling exhibit. Once the project was completed, an opening at the museum allowed her to remain there. While Fullenkamp is new to the field of museums and exhibit design, she says, "I have a broader background in foundation, design in general, and project management."

**Design values.** In the interview Fullenkamp tended to speak on behalf of the Children's Museum of Pittsburgh. As a result, the following design values reflect more on the philosophy of the museum in general, and less about specific design values that Fullenkamp personally follows.

***Create multiple entry points.*** Exhibits that are designed at the Children's Museum of Pittsburgh are designed to have "multiple entry points." According to Fullenkamp, these are not physical entry points, such as a multi-sided exhibit with many approachable angles. Instead, these are conceptual entry points. Fullenkamp explains it by saying, "there isn't only one way to enjoy an exhibit or experience the exhibit… Somebody who's fifteen can find something in it; someone that's two can find something in it." Exhibits with multiple entry points also tend to be very open-ended, meaning each experience is different and is tailored to the individual. The Studio is an exhibition area that exemplifies the value of multiple entry points (see Figure 6).


*Figure 6.* The Studio at the Children's Museum of Pittsburgh.

The Studio at the Children's Museum of Pittsburgh is a large, open room that is filled with many different art stations. These stations feature creative activities such as painting, printmaking, papermaking, working with clay, weaving, and silkscreening. Interspersed throughout the room are facilitators that help children and parents alike in the various art activities. The room in and of itself invites creativity. Hanging from the ceiling are long strands of orange and pink surveyor's flagging tape, 890 strong. This colorful area invites guests of any age to participate in any activity they would like. According to Fullenkamp,

> [The Studio] really represents the best in that kind of multiple entry points, open-ended [experiences], because when we just put paint out there, anybody can do whatever…There's no skills required. The two-year old, just holding the brush and making a big mess on the paper, is right beside an older child or an adult who's making a very specific painting with very specific skills. So that's where you can have many people of various skills just together. It's no guidance. It's whatever. [It's] letting your creativity lead the way.

Fullenkamp illustrates that anyone, with any background, can participate in activities at The Studio. Each person can have a meaningful experience, because it is geared towards such a varied audience. The success of the experience can be obtained on many levels. "Our studio is the pinnacle of that kind of [multiple entry point] experience," says Fullenkamp.

The design team at the Children's Museum of Pittsburgh also tries to avoid creating exhibits that are made for only a specific type of guest or purpose. Fullenkamp explained that guests

> come to things or learn things in different ways. If you have it open-ended enough, two different children might approach an activity differently. But in the end they still get to play and get the benefit from it, rather than one getting it right away and then the other not and leaving frustrated because they couldn't figure it out.

The Studio exemplifies the design value of multiple entry points. Guests in The Studio are invited to participate in whatever activity they would like. Then when at a specific art station, they are invited to create whatever they would like. There are no limitations here. Creativity has free range.

***Play with real materials.*** A primary design value that all exhibit designers follow at the Children's Museum of Pittsburgh is to create exhibits that encourage visitors to "play with real stuff." Fullenkamp describes it as, "Showing how the real things are made." As a result of this design value most of the exhibits developed at the museum are very exposed, meaning guests are "show[n] how things are put together." It is not uncommon to see a lot of wood and clear-coated metal; however, the museum uses laminates and plastics as infrequently as possible.

The Garage Workshop at the Children's Museum of Pittsburgh contains a tinkering area (see Figure 7). A sign posted on the wall literally invites guests to "Please… Come tinker in the

garage workshop." Another one, printed on an arrow says, "Workshop: Tinker Here." Once in the workshop, parents and children alike are given real hardware tools, and real nuts, bolts, and wood, to create any object they would like. This tinkering area also engages guests through the use of multiple entry points. Guests can begin tinkering and create something meaningful for them.

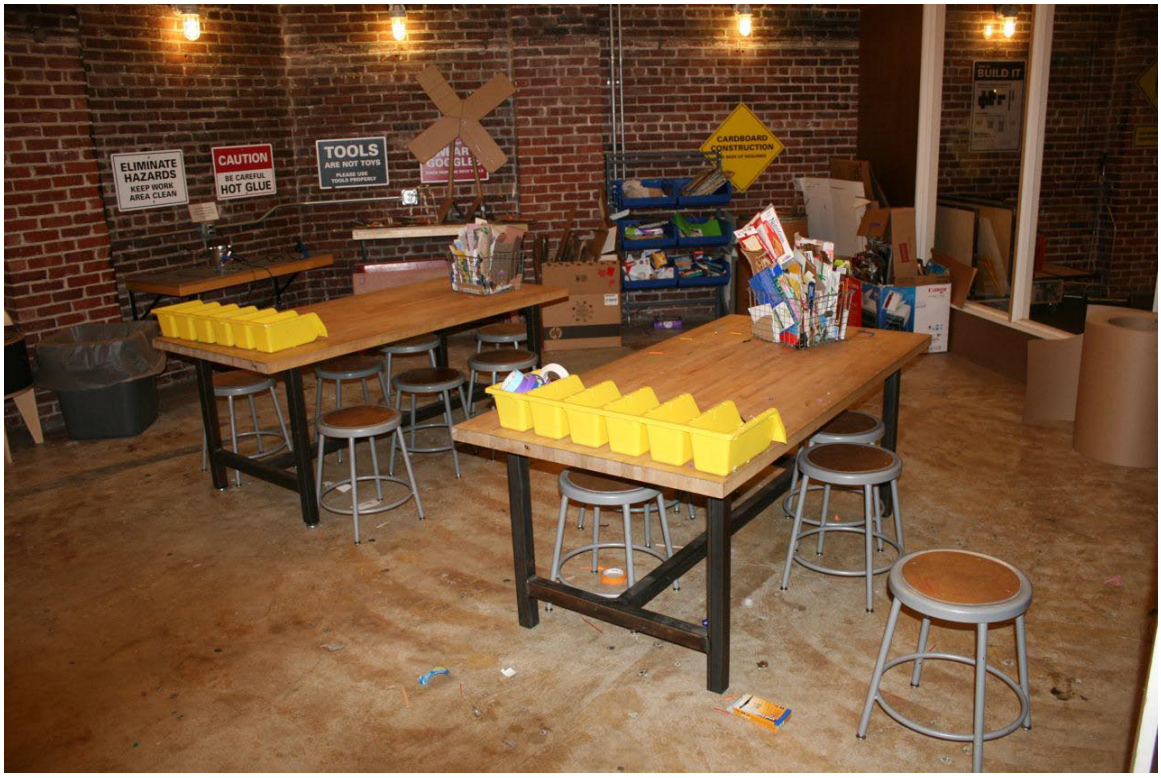


*Figure 7.* The Garage Workshop tinker room at the Children's Museum of Pittsburgh.

Just outside the tinkering area is a remainder of a real Smart car. In this section of the Garage Workshop children are invited to get in the car and pretend that they are driving, play with the buttons, or role-play with their parents. Fullenkamp explains that there are limitations when designing with the intent to play with real stuff. She says, "We have a real car…[and] we want to play with real stuff, but all the modifications that had to be made [to keep it safe] basically strip it away. All the things that make it a car are gone. The steering wheel barely moves." It is during these design decision moments that compromises are made. When

speaking about the Smart car Fullenkamp continued, “The most important thing is the play and the engagement, and those multiple entry points, and the concept, and then the real stuff. Although, I think that [real stuff] starts as the priority, through the process of the design [real stuff] probably becomes the secondary.”

Often playing with real stuff means getting messy. Fullenkamp says that some people call the Children’s Museum of Pittsburgh a “messy museum.” But, “We’re fine with that; kids will get messy,” explains Fullenkamp. The Studio is a prime place where visitors can get messy playing with real stuff:

> Paint ends up on the floor, but that's part of [the experience]. We provide smocks and things, but usually people, after they've been here at least once…come to understand that and appreciate that. We are kind of called the messy museum…especially with the painting activities. You will get paint on you. But that's part of the [experience. It’s what] happens in a real artist studio.

To the Children’s Museum of Pittsburgh it is worth allowing the visitors to get messy or to even allow them to get parts of the museums messy. This is part of what it means to participate in lifelike activities. The museum strives to create authentic experiences that will encourage guests to return and experience those same things again.

There is an outdoor section of the museum which contains a large basin full of wet clay. Guests at the exhibit determine how much air is pumped into the clay. The result is an ever-changing surface of bursting mud bubbles. “People are sometimes very surprised that we have mud, but kids like to play in the mud,” says Fullenkamp. Apparently the messy activities do not deter parents from returning with their children. Fullenkamp argues that the value of playing

with real stuff is compelling enough that visitors will return again and again despite the reality that they will likely get dirty. “You’re going to get messy, right? And that’s okay.”

***Design for families.*** When designing for families Fullenkamp says, “Our goal age, we say, is zero to eighty.” Fullenkamp understands that the people who are primarily responsible for children coming to the museum are the parents. She explains, “If the parent is interested then everybody is willing to stay longer.”

One of the first areas in the Children’s Museum of Pittsburgh is the colorful Welcome to Mister Rogers’ Neighborhood exhibition. This space allows children and parents alike to reenact the *Mister Rogers’ Neighborhood* show. In one corner is Mister Rogers’ house, complete with an area to try on sweaters and sneakers. Opposite the house are the Neighborhood of Make-Believe and the Neighborhood Trolley. At Make-Believe Castle children can act on a stage or put on a puppet performance (see Figure 8). On the Neighborhood Trolley kids can play with the steering wheel and other levers while parents sit down and relax. Other Mister Rogers-based interactive exhibits are spread throughout the area.

It should be noted that the television show *Mister Rogers’ Neighborhood* was filmed in Pittsburgh. This exhibition has a deep sense of place. While other regions around the United States would enjoy having this exhibition in a local museum, it probably would not have the same sort of appeal as it does in the Children’s Museum of Pittsburgh. “Many parents [here] grew up with Mister Rogers,” says Fullenkamp. Though the space is very simple “and geared to the younger visitors,” parents who come to this area can make connections with their children as they participate in activities together. Perhaps this exhibition is able to successfully encourage meaningful family interactions because it is in Pittsburgh and parents can draw on the traditions of the town.


*Figure 8.* Make-Believe Castle in the Welcome to Mister Rogers' Neighborhood exhibit at the Children's Museum of Pittsburgh.

Family interactions take place at other areas in the museum also. In the nursery play area "we have benches that are a part of the play activities so the parents really have to be right there with the kids." The only place they can sit down is where all the action takes place. Plus, "if they can sit down and are comfortable then maybe people will stay longer and [spend more] time at each exhibit." Other steps are taken to help encourage parents to interact with their children while at the museum. Throughout the museum visitors will see on-staff educators. Interestingly these facilitators are more for adults and less for the children. Fullenkamp explains,

> We have on the floor on-staff educators in each exhibit, but they don't [do] things for the kids, they're not so in your face, like, "Hey, kids we're going to do this." It's more…talking with the parents and explaining what you and your child can do in this space, rather than doing things for them.

Perhaps the children do not need the same sort of prompting to participate in the various activities throughout the museum as the parents do.

***Make exhibits hands-on.*** Most of the exhibits throughout the museum are hands-on, meaning they are touchable. Guests can participate in a wide variety of activities that require moving and manipulating objects. Even a majority of the art pieces are hands-on. Fullenkamp calls them "interactive art." Interactive art is the museum's way of bridging the gap between more traditional hands-off art galleries and hands-on, touchable children's museum exhibits. Fullenkamp says, "Interactive art is where a visitor…is an active participant in the piece. They're actually…activating it, making something move, [or] making something happen."

An example of an interactive art exhibit in the Children's Museum of Pittsburgh is the large 8-foot-diameter spinning disc, which is full of sand and glass beads, created by the artist Ned Kahn (see Figure 9). With this exhibit, guests are encouraged to spin the disc, which is mounted at a slight sloping angle, and watch as the sand falls in an avalanche, wave-like pattern. The exhibit is rightfully called Big Avalanche. Depending on how hard the disc is spun the sand can fall quickly or slowly. Because of the nature of the activity, the sand falls differently every time.

Fullenkamp explains that when parents and children come to the Children's Museum of Pittsburgh, they come with the assumption that all the exhibits will be touchable, including the interactive art pieces. "It's inevitable, it will be touched, because we're a children's museum, and everything is touched." Instead of trying to fight against guests' expectations about the museum, the museum encourages the contracted artists to create art that will be meaningful for a more general audience. Fullenkamp explains, "We can help artists…introduce their work to new audiences that might not go to a traditional art gallery, and then…help them progress in their

work to maybe do new things that they hadn't thought of because, [of] that whole participatory aspect." The result is that both the artist and the audience benefit from the experience. The artist is able to expand his or her repertoire, while the guests have another hands-on, engaging exhibit at the museum.

*Figure 9.* The Big Avalanche spinning disc by Ned Kahn at the Children's Museum of Pittsburgh.

***Ensure accessibility and use universal design.*** The Children's Museum of Pittsburgh seeks to design exhibits that are inclusive of all their guests, including those with mental or physical impairments. Fullenkamp says, "We try to make things as accessible and open [as possible] so everyone can experience [the exhibits]. We get a lot of visitors with disabilities…and they find that they can come to the museum and really do a lot of things here." Fullenkamp has observed that designing exhibits with universal design, in other words to be ADA (Americans with Disabilities Act) accessible, has actually been simple to do at the

museum, “because when you're designing things for children it also falls within the ADA accessibility range as well.”

For the designers at the museum it is not enough that people with disabilities have a “comparable separate space [to interact with the exhibits]…We really want everyone to be around the same table,” says Fullenkamp. That is why in the tinkering area of the Garage Workshop the tables are an appropriate height for wheelchairs, and the chairs are big enough that adults can sit in them too. It can be seen that creating exhibits to be inclusive also helps the museum to accomplish the other goal of having multiple entry points.

**Prioritization of design values.** Throughout the interview Fullenkamp described several design values followed by the Children’s Museum of Pittsburgh to create successful children’s museum exhibits. Some of these values included designing to have multiple entry points, designing for families, playing with real stuff, making sure the exhibits are hands-on, and ensuring that the exhibits are accessible for all museum guests. However, when asked which of the values was most important, Fullenkamp responded by saying, “I think the success of the piece really depends on, first and foremost, the functionality.” A number one priority of Fullenkamp and the other exhibit developers at the Children’s Museum of Pittsburgh is that the exhibit needs to be working.

An exhibit that breaks frequently is frustrating for both the visitors and the exhibit designers. Fullenkamp explains that sometimes the designers will create exhibits that “look like they'll work out great and then you put them out on floor, and kids just are kids, and then…before you know it [they are] not working anymore…I don’t know how [guests break the exhibits], but they [do].” Exhibits need to be both functional and durable.

Functionality refers to more than the exhibit physically working. Fullenkamp explains that exhibits need to be understandable for the guests. Sometimes the museum staff will observe that guests are "struggling with something." Fullenkamp expounds by saying the following:

> If we watch an exhibit area or a new activity and we see that people are walking away, they seem frustrated, they'll walk away pretty quickly and move on to find something else. That is a really clear indication that something is wrong, that we didn't explain it right. Something's not working. Or people just aren't interested in it…[Or] people don't know how to start; they don't know what to do.

Parents do not like it when they cannot explain what is happening or how to perform an activity at an exhibit. It is a tragedy "when the child asks how something is done or how to do something, and if the parent can't explain it, that's really bad," says Fullenkamp. She reiterates that it is not uncommon for parents and their children to walk away from an exhibit, even when it is not broken:

> Parents really don't want to look like they don't know how to do things in their child's eyes. So they'll often, even though it's not broken…pull their kid away and say, 'This is broken,' or 'We don't want to do this.' [Perhaps] they just don't know how to do it or they're not reading the directions or there is something that the adult is missing.

An exhibit that performs well for the designers may not work well for the guests. These exhibits almost set the guests up for failure. To Fullenkamp that does not represent failure on the part of the guests, instead the blame rests with the exhibit developers. Fullenkamp says, "We want to try to provide enough visual cues or signs and directions to let the parent or the child engage in [the exhibit] pretty quickly." From Fullenkamp's comments it can be observed that it

is important for the museum designers to conform their exhibits to the guests' needs. It is unlikely that the guests will conform to the exhibit.

The other design values are also important, and according to Fullenkamp there is at least a minor amount of hierarchy among them. While playing with real stuff is important, it comes after values such as functionality and multiple entry points. "We're more flexible on the real stuff. That's the starting point and the goal, but you can't always make the real stuff work for a variety of reasons," says Fullenkamp. It was discussed earlier how playing with real stuff had to be compromised with the Smart car in the Garage Workshop. It would have been preferable to have the car as is, unmodified. However, for safety reasons and functionality, it had to be altered.

Other design values that were discussed by Fullenkamp did not seem to be prioritized into any particular order of importance or preferability.

**Desirable outcomes.** The following are desirable outcomes that Fullenkamp and other exhibit designers seek to achieve when designing exhibits at the Children's Museum of Pittsburgh. These outcomes focus primarily on the visitors and not on the exhibits themselves.

***Help visitors have fun.*** "We want visitors to spend time at each exhibit." To accomplish this goal, exhibits need to be compelling, interesting, and, perhaps most important of all, fun. Visitors "don't have to come away, learning a principle," insists Fullenkamp. Hopefully they would come away saying something like, "Oh, I didn't know that…was fun." While the informal learning is important, it is secondary to having an enjoyable time. Adults are included in this. Fullenkamp explains, "A big part of our philosophy is play. Adults need to play; everybody needs to play…[If the visitors] had fun, they want to come back." In Fullenkamp's mind, "It's pretty basic."

Having fun at the Children's Museum of Pittsburgh is different than experiencing thrills like you might at an amusement park. Families at the museum should be able to "come in for the day and have enough different experiences that are enjoyable to [a] wide-range of ages…Everyone can spend the day [there]." She warns that even adults "might be surprised that they had fun."

"We want people to have a good time, be safe and, maybe do something new or something that they don't get to do everyday," says Fullenkamp. The Gravity Room definitely fits this mantra. The Gravity Room is housed in The Attic exhibition hall. Visitors get to the room by ascending a small flight of stairs. Once in the Gravity Room visitors will observe that the floor is tilted downwards at a 25-degree angle, as well as most of the objects in the room. The result is a sensory perception that tricks the minds of the visitor to thinking that they are standing at an angle and that everything else in the room is straight. Then at the end of the Gravity Room is a steep slide that takes the visitors back to The Attic. Fullenkamp says, "I think kids love [the Gravity Room]. They'll go around and around and around and do it, over and over and over again." Parents will find themselves enjoying the experience too. "It's a slide, it's fast, it's a tilted room, it's a physical thing. It's cool…[We] see adults going down our slides," says Fullenkamp. It is no wonder that Fullenkamp calls the Gravity Room one of the museum's most popular exhibits.

***Foster meaningful family time.*** When designing exhibits for the Children's Museum of Pittsburgh Fullenkamp strives to increase the amount of meaningful "family time" at the museum (27). To her this means that the parents are doing things such as "turning their cell phones…Blackberrys, and iPhones [off], and putting them away." They are also "laughing [with their children] and spending time together in a really relaxed way."

The challenge for the exhibit developers then becomes to see if they can create exhibits that not only engage the children but also engage the parents. "We see great moments in these families' lives," says Fullenkamp, "and we just hope…that the parent didn't miss it, because they were texting [or checking their emails]." To facilitate the meaningful family time the museum avoids creating exhibits that are fun for the kids but are "annoying to [the] adults." Fullenkamp compares parents at unappealing exhibits to parents taking their kids to "a kiddie movie that [they] hate." A parent may tolerate the obnoxious movie, but they cannot wait to get out of the movie theater. An exhibit can have the same effect. If it is only meant for little children, parents may tolerate it once or twice. If this persists the parents may take their child to the museum without having any intention of getting involved themselves. The result will likely lead the parents, who are the real decision makers, to argue for a different venue instead of a museum visit. Fullenkamp sums the challenge up by saying, "In terms of the long-term sustainability of your museum, you [have to] try to get generations together…Remember that adults come with the children, and you don't have to dumb everything down to some kind of cartoon."

The Studio is a prime place where families can spend time together in engaging activities. The exhibition space is a large, open rectangular room "so everyone can see everybody…A family can come in and do separate activities, but still be together…Mom can be with the younger siblings over at the painting, and Dad can be over at the silk screening with the older children," says Fullenkamp. The Studio is an exhibition space that is not just appealing for the children. Parents can enjoy getting involved too. Meaningful family interactions are more likely to occur when parents interact with the exhibits alongside their children.

**Conclusion.** The Children's Museum of Pittsburgh case study had brought to light several design values used by Anne Fullenkamp, one of the museum's exhibit developers. She

has spoken on behalf of the museum in general. Some of the values featured include creating multiple entry points, playing with real stuff, designing for families, ensuring the exhibits are hands-on, and making the exhibits accessible for all visitors, regardless of disabilities. Fullenkamp also emphasized the importance of functionality as it relates to the exhibits. The following paragraphs are additional assertions about the design values used by Fullenkamp and the Children's Museum of Pittsburgh.

While the museum is called a children's museum, it could just as appropriately be called a family museum. Fullenkamp reiterated again and again that the adults need to be engaged just like the children. "If the parent is interested then everybody [will be] willing to stay longer." It was also apparent from personal observations that the museum acknowledged adults as a primary audience and did their best to not only get them involved, but get them involved in meaningful interactions with their children. This was made clear through the use of inviting signage and multi-age-appropriate activities.

Guests find appeal in the amount of openness that exists throughout the museum. In The Studio is a major exhibition space in the museum where visitors are free to choose any activity they would like to engage in. Then when participating in that activity, they can create whatever they would like. This is the case at the Garage Workshop tinkering area too. The open-ended nature of these exhibits likely increases the amount of repeat visitors, because the experience will be new every time.

Similar to Durrell's explanations of the exhibits at the Boston Children's Museum, most of the exhibits at the Children's Museum of Pittsburgh also incorporate many design values at a time. Again The Studio and Garage Workshop tinkering area are used as examples. These exhibits have multiple entry points, allow guests to play with real stuff, provide families with

opportunities to work together, encourage hands-on experiences, and are accessible by anyone. Thus, an exhibit is often successful not because it embodies a single design value, but because it encompasses several values at a time.

In this case study a few of the design values used by Fullenkamp at the Children's Museum of Pittsburgh have been discussed. The exhibits featured represent a small number of exhibits that are actually in the museum. Further insights could also be gathered by researching those other exhibits. The exhibits featured in this case were selected because they were directly discussed by Fullenkamp; they also seemed to exemplify the design values that she and the other exhibit developers use.

**The Children's Museum of Houston**

The Children's Museum of Houston has been in operation since 1980. It is dedicated to "transforming communities through innovative, child-centered learning" (Children's Museum of Houston History and Mission web page, 2011). Keith Ostfeld is the Director of Exhibit Development at the Children's Museum of Houston. He started his career as a high school and middle school science teacher. After teaching for a few years he was hired onto the staff at the museum as a science educator. He began his work at the museum by helping revamp some of the science exhibits. After eight years, and five positions later, he became the Director of Exhibit Development.

At the time that the interview with Ostfeld was conducted, the museum was under a major expansion to double the museum's exhibit space and was set to open a few months later. The comments and observations expressed in this case study do not reflect the recent, major addition to the museum.

**Design values.** The following sections represent design values used by Ostfeld and the Children's Museum of Houston when designing exhibits.

***Center design on family learning.*** The primary design value that directs the work of Ostfeld and the other exhibit developers at the Children's Museum of Houston is family learning. "We see that family learning is, of course, [our] centerpiece," says Ostfeld. He explains that family learning takes place all the time.

> A lot of parents don't understand [that the role of teacher] is a role that they take on and [that] what they do on an everyday basis is educational. A lot think, "Okay, education happens in schools and I'm just doing stuff at home and maybe I'll teach them some values or things like that." But in fact they teach them constantly. Everything that [a parent does] is something that [their] kid is going to pick up on at some point.

The staff at the Children's Museum of Houston recognizes that their primary audience is families. "We mostly see families," says Ostfeld. Designing an exhibit for a family requires thinking about family learning from the very beginning of the design process. When developing an exhibit Ostfeld will often ask himself, "What is my family going to do here?" He continues by saying, "It's not about the kid doing something, or a school group doing something, but rather what will my family do here?" From Ostfeld's statements it is seen that family learning needs to be the center of thought from beginning to end. It is not enough to design an exhibit and then consider how to get an entire family involved. Ostfeld further explains,

> At the very…beginning when you are starting pie-in-the-sky, [when] you're doing a lot of brainstorming, and you're just kind of throwing out ideas and you start going through those ideas and you start [thinking], "You know, this is really just an individual experience. I'm not seeing a lot of family interaction with this idea, so we're going to

> kind of put this one off to the side…[Or] let's think about this. Is there a way that we can get the family more involved in this particular piece? What's going to excite the kids, and what's gonna make the parents want to come over and work with the kids?"

For Ostfeld these are important questions to ask when developing an exhibit. It is not enough to appeal to one end of the audience spectrum. Both the children and the parents need to be engaged. "We're not Chuck E. Cheese," says Ostfeld. Parents need to be with the children, not just to prevent misbehaving, "but also so that [the parents] can learn with [their children]."

In the Building Zone, an exhibition hall in the Children's Museum of Houston, there are several exhibits that encourage family learning and interaction. The first is an area where children and parents can work together to build a freestanding arch out of large, cushiony building blocks (see Figure 10). Young children will have a difficult time accomplishing this activity by themselves. It works best where there are multiple people, preferably a parent to help hold up the arch pieces until the final piece, the keystone, is placed on the top of the arch. This activity is challenging enough that a young child would not be able to do it by himself or herself. Help from a parent is needed. This activity has the appropriate amount of challenge, because it does not leave a child or parent feeling frustrated because they could not figure out what they were supposed to do.

Another exhibit in the Building Zone called Clubhouse Design is also challenging enough for young children that they would need the help of an adult to be successful (see Figure 11). This exhibit allows guests to use long, flat pieces of wood with notches in them to create large, three-dimensional structures. These pieces of wood look like large two-dimensional Lincoln Logs, and they interconnect in much the same way. Notches from one piece of wood are interconnected with other notches from alternating pieces of wood.

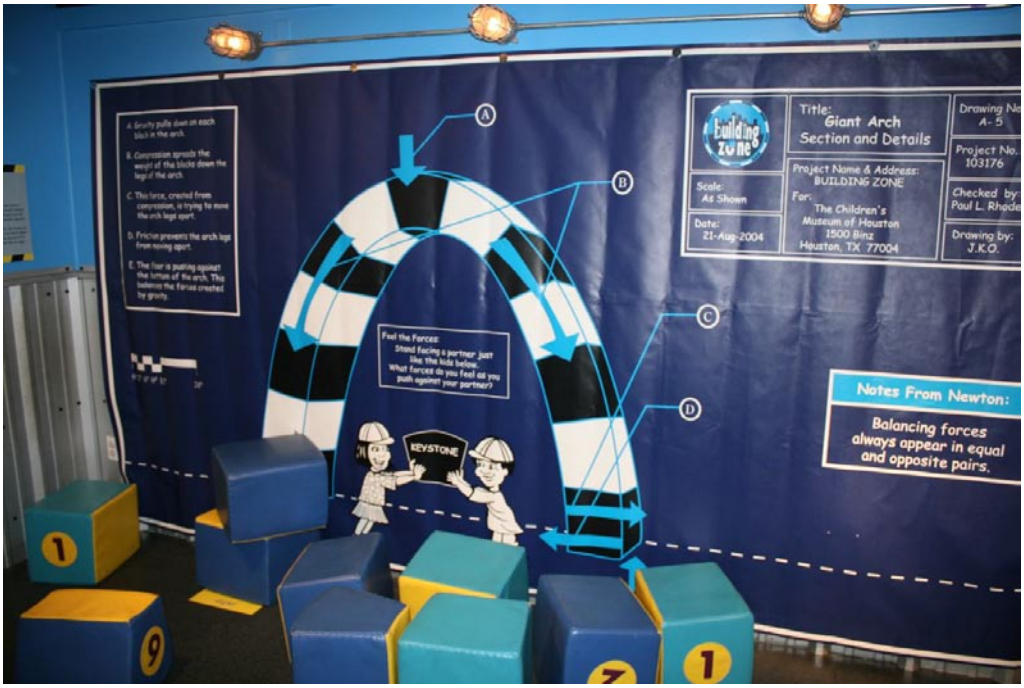


*Figure 10.* The arch building exhibit in the Building Zone at the Children's Museum of Houston.


*Figure 11.* The Clubhouse Design exhibit in the Building Zone at the Children's Museum of Houston.

This exhibit is a place where family learning can take place, not only because the activity is challenging for young children. Clubhouse Design provides opportunities for children and parents to participate in creativity and decision making together. Unlike the build an arch exhibit previously mentioned, this Clubhouse Design space is much more open-ended. Guests can build many kinds of structures. This activity facilitates opportunities for parents to ask questions such as, "What would you like to build? Do you want your clubhouse to have windows? What are we going to need to do to make sure the clubhouse turns out the way we want? What pieces will we need?" Together the parents and children get to choose how they would like to construct their building.

Throughout the museum parents will see hints that show them how to get involved with their children at the exhibits. Ostfeld says, "We have signs, and they say, 'Hey parents…'." He recognizes that it is an overt way to get parents involved, but it has worked for them. Sometimes they will get a parent who feels intimidated by the subject matter of an exhibit. Such is the case at the Cyberchase exhibit. "It's a math exhibit and…a lot of parents are…math phobic… [Sometimes] a parent sees a fraction, so they just shut down a little bit." The signs show simple ways that the parents can get involved in the learning during the activity.

The goal of the signs is not to just help parents overcome their fears about getting involved at the exhibit, but they are also used to show how parents can continue learning with their children outside the museum. "Our goal was, 'Hey, what can you do with your kids at home to extend the learning that they're doing here?'." Other "hints" exist throughout the museum that help encourage parents and children to engage in learning activities after their visit. Ostfeld explains,

> We have take-home sheets everywhere [that allow the families to] do the learning at home…[Or] there's a whole bunch of math games out…and [they] can take them all home, along with a book. And when [they] go home [they] now have [their] book of math games. [The parents might say], "I can now play with my kids or my kids can play with me." And [the kids might] say, "Hey, I want to play the [museum] games with you."

The activities and games in the take-home material are very simple, and they encourage parents to use everyday objects in their teaching. Ostfeld says, "We're not asking parents to build very complex things." But when they help teach their children, both the parents and the children are "learning, and they're seeing this topic from many different angles. It's going to cement the idea much better in their minds, or the skills much better in their minds, than if they'd just encountered it here [at the museum] for 30 seconds."

According to Ostfeld, family learning is something that can take place anywhere. It does not only exist in the museum. It can happen at the museum, at home, or anywhere in between. While the museum seeks to facilitate family learning at the museum, it also provides hints to help parents continue meaningful conversations and learning opportunities with their children after they leave.

***Follow DEEP principles.*** The Children's Museum of Houston adheres to a compound set of design values: Design for innovation, Exceed Expectations, and Personalize the learning (DEEP). These values are all intended to work together to increase the amount of family learning that takes place throughout the museum. Ostfeld calls them strategies. "The goal basically is to deepen learning and to increase the ability for kids to…wrap their minds around that what they do here has impact upon other areas of their lives," says Ostfeld.

When an exhibit is being designed at the Children's Museum of Houston, the staff at the museum will design for innovation. They are not afraid to try new things, experiment with the latest technologies, and rethink concepts. Also, because the Children's Museum of Houston is renown nationally among children's museums around the world, they seek continually to exceed expectations. A web article published in February 2011 on the Parents.com website noted that the Children's Museum of Houston is now the number one rated children's museum in the United States, according to parents who attend children's museums (Cicero, 2011). Lastly, Ostfeld says the museum personalizes learning by focusing on "inquiry, discovery, modeling, your basic traditional pieces, including conversation and then what we call people-to-people learning, which is both within the family and us as staff working with the family."

The three DEEP strategies help Ostfeld and the other museum staff members focus their efforts to accomplish, what Ostfeld calls, the things "we do well." He continues, "We do culture and society well. We do human development and early learning very well. Literacy and communication, problem solving and creative thinking, science and math." The Children's Museum of Houston is one museum among a larger set of museums in Houston. Among this group of museums is an unwritten rule that each museum has their expertise, and they should not infringe on each other's areas of emphasis. "We do not do space, because…there is the Space Center Houston…We do not do dinosaurs…The Museum of Natural Science…[does] dinosaurs."

The DEEP values were used extensively to create the exhibits in the recent expansion to the museum. Ostfeld explains one exhibit, called Cyberchase seeks to deepen learning by answering the question, "What can you do with your kids at home to extend the learning that they're doing here?" Cyberchase is an exhibit where children and parents are able to experiment

with math concepts such as “place value, algebra, geometry, fractions and probability” (Children’s Museum of Houston Cyberchase web page, 2011). Here children and parents can participate together in math-related activities. The goal is to reinforce the learning that is already taking place at home or school. Ostfeld gives an example by saying, “So I go to Cyberchase and I spend some time in Cyberchase and I have a good time. And then I go to school and then, sure enough, suddenly there's a [lesson] there on the same math topic.” Ostfeld and other exhibit developers do not want to take away from the learning that is already happening in a child’s life. Instead, they want to deepen it in any meaningful way they can.

***Offer special programs.*** Ostfeld explains that the actual exhibits at the Children’s Museum of Houston take up a very small portion of the museum’s emphasis. Special programming is also used to accomplish the museum’s goals. “Part of [our emphasis] is, of course, exhibits, but it's very small compared to…all these other things that we do as well. We don’t just focus on exhibits…Some museums really do just focus on the exhibits and that's fine,” says Ostfeld. But for the Children’s Museum of Houston, their focus expands to “everything from activity guides, professional development, family-parent events, afterschool events, so forth and so on.” Ostfeld explains the museum’s emphases also include, “outreach efforts…[and] festivals.” Two specific additional programs were discussed by Ostfeld: National Engineering Week and Nano Days Week.

Ostfeld explains, “When we do National Engineering Week we bring in engineers from The American Society of Civil Engineers, The Society of Women Engineers, and various student organizations on the Rice Campus and the University of Houston Campus.” When these volunteers come to the museum they help facilitate guest experiences by “[working] with the families.” This provides guests with the unique opportunity of being able to talk one-on-one

with expert engineers in the field. The Nano Days Week has volunteers that come in from the Center for Biological and Environmental Nanotechnology at Rice University. These volunteers interact with guests who often have never even heard of nanotechnology, and "all of a sudden [the guests are] seeing horizons open. It's like, wow, [these are] opportunities that my kids can actually take advantage of at some point" says Ostfeld.

Other special programs that exist at the museum that were not discussed by Ostfeld include Free Family Nights, where entire families get in for free on Thursday evenings; scouting activities, which even include a Cub Scout or Girl Scout overnighter; school field trips; FLIP (Family Literacy Involvement Program) Kits; and story time for children. Private events such as birthday parties can be hosted at the museum as well as corporate events. Recognizing the importance of additional programming requires Ostfeld and other developers to think outside the narrow field of exhibit design. This forces them to create exhibits that are versatile enough that they can be used for additional purposes.

***Ensure simplicity.*** Exhibits at the Children's Museum of Houston must be simple. For Ostfeld it is simple enough when "people can go up and have a relatively successful experience at a component without necessarily needing to read the sign." Often visitors' experiences are diminished when they do not understand what they are supposed to do at a particular exhibit. Exhibits need to be so explicit that minimal or no reading is required.

One of the reasons that the exhibits and signage at the museum must be simple is because of the illiteracy and diverse ethnicities that exist in Houston. As a result, "We…typically run a fourth grade level of reading level [on our signs]," so that those with literacy challenges are able to read it too. Sometimes they will see children reading the signs to their parents, "so the parents can then help [the children]" participate in the activity, explains Ostfeld. Additionally, most of

the signage is printed in both English and Spanish to accommodate for most of the visitors who attend the museum.

There are some exhibits in the main hall that are very simple. They are known as the Junktion exhibits. Junktion is made up of several differing cart stations. Stations include face painting, puppetry, wind tubes, and other small crafts. The carts and their activities change regularly based on themes. Posted on each cart is a simple set of instructions. Sometimes a simple photograph will be posted to show the end result of the activity. Guests are then able to get a sense for what they are supposed to do at the exhibit just seeing the picture. For the face painting exhibit a simple sign is posted on a mirror (see Figure 12). The sign is in both English and Spanish. It includes a brief sentence of instruction, which reads, "Paint a design on your face." Also posted is one safety tip and one cleaning tip. In the middle of the two languages of instruction is a photograph of a young girl with whiskers and a red nose painted onto her face. The activity and signage are so simple that almost all museum guests, regardless of age, ethnicity, or literacy level, are able to participate in the activity.


*Figure 12.* The face painting station as a part of the Junktion exhibition area at the Children's Museum of Houston. Photograph used with permission.

**Prioritization of design values.** As was noted earlier, the central design value, and therefore highest priority design value, used by Ostfeld and the Children's Museum of Houston is family learning. Family learning is considered from the beginning of the design conception, and is carried through to the actual production and implementation of the exhibit. After it is completed, if the exhibit is not facilitating meaningful learning experience for families then, "There's something wrong with this [exhibit, and] we actually…try to figure out what we can do to fix it," says Ostfeld.

Surrounding the central value of family learning is the DEEP initiative: design for innovation, exceed expectations, and personalize the learning. It is assumed that other design values used by the Children's Museum of Houston branch off of family learning and the DEEP values. Unfortunately no other information was gathered from Ostfeld concerning the prioritization of design values.

**Desirable outcomes.** The following are desirable outcomes that Ostfeld and other exhibit designers seek to achieve when designing exhibits at the Children's Museum of Houston. These outcomes focus primarily on the visitors and not on the exhibits themselves.

***Promote family interaction.*** When speaking about the kind of outcomes they would like visitors to have Ostfeld said, "One of the most important pieces is that you have got to have family interaction." To accomplish this Ostfeld says, "We tend to look for things that are going to engage the parents as well as the kids. What you need is…to have that parent interaction or at least an older child-younger child interaction." Often parents will come to the museum with the expectation that the museum will entertain their children for a few hours. These parents will discover that the experiences they have at the museum are much more meaningful. Ostfeld explains, "The kids start taking up so many things, and then all of a sudden they [and their

parents] get these moments where they [all] draw upon their experiences here back [to]…another setting."

"We look for the parents to engage the kids in conversation, or better yet the kids engage the parents," says Ostfeld. Family interaction is a natural result of the developers centering all of their design on family learning. When looking for family learning the museum evaluators and developers use an informal sliding scale to rate the quality of family interaction that is taking place. Ostfeld describes it as follows:

> We don't say, "Yes, we have family learning", but rather, "We had a family learning that was about 9 out of 10," or "We had a family learning that was more like 4 out of 10," where it might be more like the parent and the child sat down at the activity. They did it together, they talked a little bit, and then they left. That happens, you know… [Sometimes] the parent is off somewhere else, or we never get a parent over at this particular component with the kids. The kids touch it and walk away. [That means] there's something wrong with this component.

When there is a lack of family interaction with one of the exhibits they do not necessarily eliminate it, "We actually…try to figure out what we can do to fix [the exhibit]…We hate to scrap ideas. There's a reason that this idea made it all the way as far as it did. People liked it here on staff. There was a reason that we liked it here on staff." Often the exhibits can be reconditioned to make them more appealing for families.

***Maintain understandability and relevance.*** Along with helping families to engage in meaningful interactions, Ostfeld says that exhibits needs to be understandable and relevant to guests' lives. In the How Does It Work gallery the museum designed a standing wave generator that was meant to show waveforms and patterns. The wave generator sits on the floor and

ascends up about ten feet (see Figure 13). Attached to the middle column are several metal rods that swivel back and forth. Guests spin a large disc at the bottom of the structure to create their own wave patterns that move from floor to ceiling in the metal rods. "[Sounds] cool" says Ostfeld, "[But] the problem with this is that the disc spins all the way around. So we hear most often, 'Look, it's DNA!'." Unfortunately the wave generator has nothing to do with DNA, and it "doesn't look anything like DNA." The wave generator was an exhibit that the design staff at the museum had to redesign so that it was understandable.

There have been other exhibits in the How Does It Work exhibition area that have also been eliminated or replaced. Ostfeld explains why this is the case.

> We could never get anyone interested in [the exhibits]. It was outdated technology in some cases. There was an eight-year old piece, and the technology we were showing off there had become outdated. No one [was] interested in it anymore, or they could never understand it. It was just so far away from their daily lives, or it was presented so poorly.

Similar to other exhibits, the museum did the best they could to salvage the exhibits, to modify them in a way to make them relevant for guests again. When "there was just nothing we could do with it…[we would] scrap [the exhibits] and start over again," says Ostfeld. Exhibits must be relevant to the guests; otherwise they will be passed over.

***Empower visitors through choices.*** One of the outcomes that Ostfeld and the Children's Museum of Houston seek to achieve is to empower their guests, particularly the children. Ostfeld and the museum call it, "Your voice, your choice." One way that people become empowered is by making decisions. The museum provides many opportunities for young people to make choices, particularly through the use of role-play.

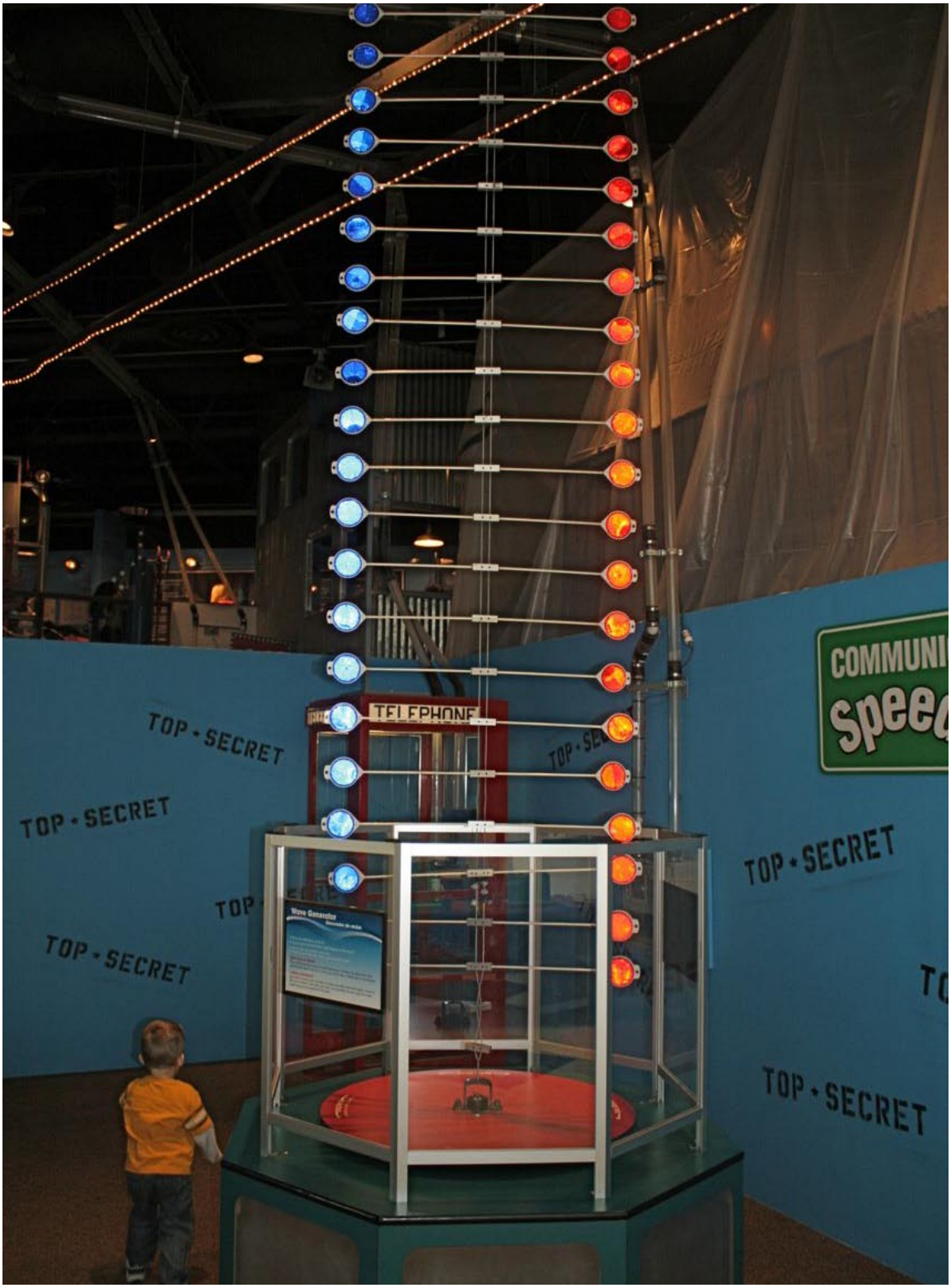


*Figure 13.* The wave generator in the How Does It Work exhibition hall at the Children's Museum of Houston.

The Farm to Market exhibit, which Ostfeld calls "a classic children's museum exhibit," strives to empower children through the use of role-play (see Figure 14). In the market children get to pretend that they are buying real food. "It really gets at the concept of role-playing [and decision making] in play," says Ostfeld. To participate in this activity children pick up a nearby grocery basket. They can then select which items they would like to purchase from the market. Then they can engage in a simulated purchasing activity. As a result of this activity, children are able to make decisions about what they would like to buy, how much of each item to get, and what they would like to do with the food once they have gathered all of it. This activity also encourages children to clean up afterwards, thus providing them with an opportunity to learn through sorting.


*Figure 14.* The Farm to Market exhibit at the Children's Museum of Houston.

Apparently the Farm to Market exhibit no longer exists in the form that I saw it in during my visit to the Children's Museum of Houston. It has become an extension to a much larger

exhibition called Kidtropolis. The empowering use of role-play still has a major role in the new exhibit. Ostfeld calls Kidtropolis a "city that's run by kids…The economic system is kids, and it really gets into true economics. It gets into true civic engagement." Here children get to role-play being in charge of the city. It is similar to the Farm to Market exhibit, but more in-depth and lifelike. At the entrance to the exhibit children receive something that acts like a debit card. They are then given money on their card that they can use to spend throughout Kidtropolis. If they run out of money they can earn some by taking on different jobs throughout the town. Thus the children receive experiences that teach them about how choices affect results. They become empowered to make positive choices due to the experiences they have at the museum.

**Conclusion.** The Children's Museum of Houston case study has highlighted several design values used by Ostfeld and other developers at the museum. These design values include family learning; DEEP: Design for innovation, Exceed Expectations, and Personalize the learning; special programming, and simplicity. Family learning is the central value from which all the other values stem. The following paragraphs represent other assertions about the Children's Museum of Houston and the design values used by Ostfeld.

The Children's Museum of Houston has not garnered all their success from their exhibits alone. Special programming, including outreach programs, family-centered events, and a special working relationship with the other museums in Houston has helped them to proclaim their message to many people. Their success is pushed beyond the walls of the museum. The special programming at the museum provides guests with the opportunities to make greater connections with their family members and with the exhibits both inside and outside the museum. This is in large part due to the volunteers or staff members that facilitate the families' experiences.

Ostfeld and the Children's Museum of Houston use the same set of design values to create exhibits for a large variety of subjects. Subjects that the museum covers include mathematics, technology, engineering, science, physics, reading, art, play, fitness, role-playing, economics, and ecosystems. The same design value can be used in many different circumstances. For example, family learning was used as a central value in creating the Farm to Market exhibit, which is heavily based on role-playing and economics. However, family learning is a central value at another exhibit called Motion Commotion, which is primarily a physics exhibit, similar to the Raceways exhibit at the Boston Children's Museum. The same could be said about the other design values, such as DEEP and simplicity as well.

While all of the other case studies could have used additional research performed to learn more about them, the Children's Museum of Houston is perhaps the museum that would benefit the most from another look. This is because of the major expansion that doubled the exhibit space at the museum. As was noted earlier, in February of 2011 Parents.com rated the Children's Museum of Houston the number one children's museum in the nation; certainly the expansion would have led to a higher rating among visitors of children's museums. Additional insights about design values could be learned from evaluating the new exhibits at the museum.

**Science City**

Science City is an interactive science center that is housed within a larger museum complex called Union Station Kansas City. What was once a large train station was converted into a cultural and entertainment center. Included in the 1999 renovation of the station was Science City. While Science City is considered a science center, it also has the look and feel of a children's museum. Part of the goal of Union Station at large is to "educate people of all ages…in the exploration of science, and to assist in experiencing old and new technologies

affecting our lives and inspiring others to become innovators in developing technologies for the future" (Union Station Kansas City Mission and Goals web page, 2011). While Science City is not a children's museum per se, the exhibits and activities in the center are clearly appropriate for guests of all ages, including young children.

Matt Christopher is the Paleontologist and Education Department Manager for Science City, although he says, "I wear a LOT of hats here," meaning he is responsible for many different tasks. He has worked at the center for approximately six years. Before working for Union Station he received a master's degree in vertebrate paleontology. He was hired on at Science City to help "develop paleontological programming and the DinoLab fossil preparation and replication facility."

Unfortunately Christopher was unable to be interviewed over the telephone. However, he was able to answer some interview questions asynchronously that were sent to him over email. The result is that there was not as much data collected with this case as there were with the other cases. The following case will be as thorough as possible, but may be missing some of the rich detail that the other cases had.

**Design values.** The following sections represent design values used by Christopher and Science City at Union Station Kansas City when designing exhibits.

***Limit expenses.*** According to Christopher, "Cost is the barricade which gates the realm of possibility." This is understandable. Cost can be such a limiting factor when creating exhibits. And it can be particularly challenging to develop an exhibit on a "no-budget-for-exhibit development operation strategy" says Christopher.

To resolve the issue of cost Christopher follows a set of criteria before an exhibit can be developed. The number one criterion is, "Is it free and made completely in-house of scrap

materials? If yes, you may proceed; if no, scrap the idea right now," explains Christopher. It seems as if a portion of the budget is set aside for maintenance, but not necessarily the development of new exhibits.

When Science City opened in 1999 it began with several exhibits that were built by a Canadian design firm. Since that time funding has been cut dramatically, staff had to be downsized, and budget for new exhibits was severely tightened. The result is that many of the old or broken exhibit spaces have not necessarily been demolished and reconstructed; instead, they have been repurposed. According to Christopher, the repurposing of Science City's 3,000 square foot Body Tours exhibition only cost about $500 when "a more traditional approach would have cost over a million dollars in demolition and reconstruction."

***Design for durability and safety.*** Durability and safety are other major design values followed by Christopher. When developing exhibits, Christopher humorously asks,

> [Will the exhibit be] rugged enough to leave a 400-pound chimpanzee alone in a room with it for an extended period of time with the exhibit remaining intact? If yes, you may proceed; if it cannot be made so, you might just build it anyway to see what breaks first, provided scrap materials are abundant enough.

One of the most durable exhibits at Science City is Music Park. When guests first walk into the center they will see several uncommon music makers. On one side are some garbage cans that have been converted into synthesized drums (see Figure 15). When children hit the pads on top of the cans, sounds are produced out of a nearby speaker. Next to the garbage cans, on the floor, is a large set of piano keys that wrap around a circular wall (see Figure 16). When children step on the keys a piano sound is activated. Other sturdily built musical instruments are also nearby. Everyday both children and adults stomp up and down on the piano keys and

*Figure 15.* Garbage can drums at the Music Park exhibit at Science City.

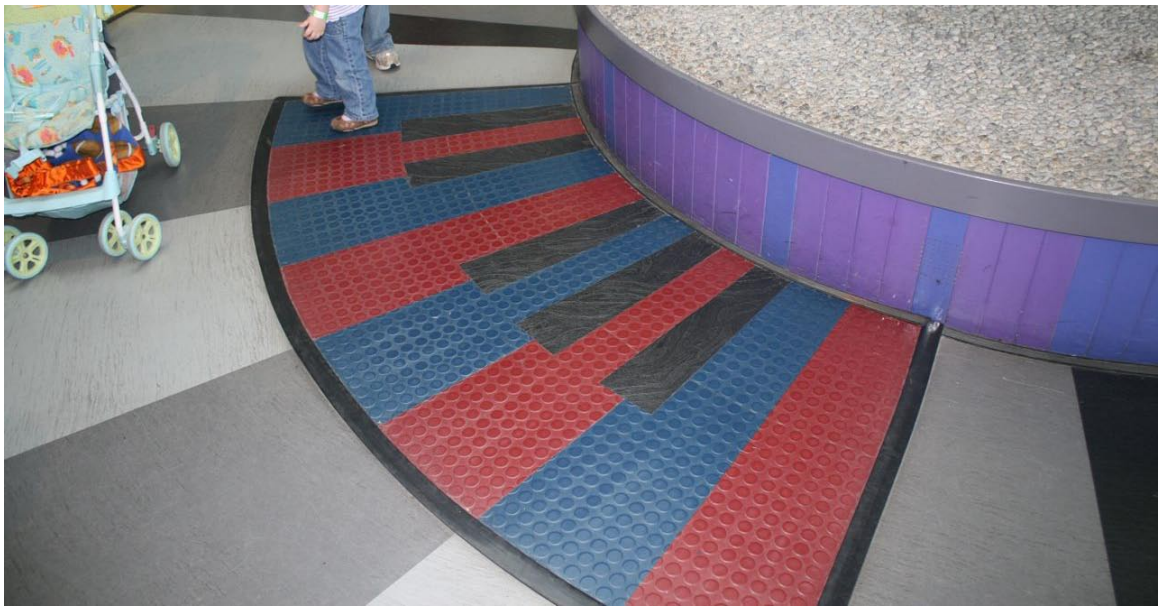

*Figure 16.* The floor piano at the Music Park exhibit at Science City.

relentlessly bang on the garbage bin drums. Exhibits at this center, particularly Music Park, need to be durable.

The exhibit at Science City must also be safe, for visitors of all ages, particularly children. Christopher says, "Is this exhibit safe enough to leave a toddler alone in a room with it for an extended period of time? If yes, you may proceed; if it cannot be made so – freely and with scrap materials of course – scrap the idea right now." If parents do not feel that the exhibits are safe they will be unwilling to bring their children to play at the center.

***Create multisensory engagement.*** Another one of the values used by Christopher to develop exhibits at Science City is multisensory engagement. This refers to the different sensory ways that guests can interact with the exhibit, including sight, sound, touch, taste, and smell. Throughout the center are exhibits that engage guests using these multiple senses.

The first sense is sight. The Mister E Hotel exhibit is one that engages the visitors in many experiences with sight through the use of optical illusions. One room in the hotel has everything slanted about 45-degrees except for the floor. Guests are encouraged to lie down on a flat surface and stare at the room for a few minutes. Doing so is supposed to trick visitors' minds into thinking that they are off balance when everything else in the room is straight. The Mister E Hotel includes other illusions, including artwork by illusionist artist M.C. Escher. Another area of the museum called Light Alley requires visitors to rely on sight. In this exhibition area are several exhibits about light and its properties, such as reflections and absorption. Visitors can participate in several activities and are able to see the effects of light in their lives.

The second sense is sound. As was already discussed the museum has Music Park, a hands-on musical interaction. Guests participate in music and sound generation by manipulating the musical instruments throughout the space.

The third sense is touch. Almost all of the exhibits throughout Science City are hands-on, meaning they are touchable. One exhibit in particular, called the Thoughts Flow water table by artist Tom Egan, engages visitors through touch by having them create rivers, currents, dams, reservoirs, and levees by placing plastic cards into slots on a table with continual running water see Figure 17). Guests will continually feel the flowing waters as well as the objects as they interact with this exhibit. There is another exhibit in the museum that relies solely on touch. It is a dark tunnel. The only way for visitors to get out of it is to feel their way through it.

*Figure 17.* Thoughts Flow water table exhibit by Tom Egan at Science City.

The fourth sense is taste. I do not recall any exhibits that featured taste. The fifth sense is smell. Perhaps the most poignant smells are inside the Nature Center (see Figure 18). This is because there are real animals inside. Guests can enter the Nature Center to see lizards, snakes, rodents, and invertebrates. Visitors have a more multisensory experience here because of the smells that permeate the enclosed Nature Center.


*Figure 18.* The Nature Center exhibition area at Science City.

***Align exhibit content with state curriculum.*** Christopher ensures that any of the exhibits that are developed at Science City are aligned with state education curriculum points. Perhaps the primary reason for doing so is to create a greater appeal to schools to attend the science center on field trips. With increasingly limiting budgets for schools and additional pressure to perform well with standardized testing, schools cannot afford to visit Science City unless it will help them accomplish their overall educational goals. Included on the Union Station website is a web page that provides links to state and national curriculum goals and how they are aligned with the exhibits at Science City (Union Station Kansas City Educator Information web page, 2011).

***Focus on aesthetics and congruency with an environment theme.*** Lastly, Christopher designs exhibits to be aesthetically pleasing that are able to fit within one of the existing environmental themes. The Canadian design firm that developed Science City's original exhibits

created a unique layout with several themes. When visitors first walk in they will notice that much of Science City truly looks like a city. There are buildings, parks, street signs, billboards, and vehicles. The facades of differing exhibition areas look like the fronts of buildings (see Figure 19). The names of the differing exhibitions are also harmonious with the themed areas, such as the City Park play area, the Periodic Table restaurant, Music Park, Light Alley, City Golf, Mister E Hotel, the Tree House, and Science City Crime Lab. Whenever new exhibits are created, they need to fit within one of the previous areas and must correspond with both the area's subject matter and aesthetic look. Christopher jests, "Does it look like it was made of scrap materials, designed by a toddler, or built by a 400-pound chimpanzee? If no, you may place it on the exhibit floor and hope for the best."


*Figure 19.* Building-like façade of Mister E Hotel exhibit at Science City.

**Prioritization of design values.** According to Christopher, the priority of design values for him is "cost, durability, [safety,]…degree of multisensory engagement, alignment to state education curriculum points, aesthetics and [congruence] within environment theme." Unfortunately no other insights were obtained about Christopher's prioritization of design values.

**Desirable outcomes.** When asked about the desirable outcomes they try to achieve at Science City, Christopher explained that they try to maximize "the engagement length, [meaning the] average time spent interacting with the exhibit." To accomplish this he states that exhibits must "[emphasize] the inherent appeal of the subject and its relationship to familiar contexts or applications." When parents and children are able to see how a particular exhibit relates to them in their personal lives then they are going to be more willing to interact with it. The interaction with the exhibit becomes meaningful when "the parent and child experience the exhibit together or one-after-the-other…[and] part of the activity sparks positive interaction between the two as they leave the exhibit, discussing what they just experienced," says Christopher.

Christopher explains that when a guest has a natural attraction to a particular subject of learning, then they are going to be more willing to spend quality time at an exhibit that covers that subject. Such is the case at the DinoLab area. Christopher explains, "If guests naturally find dinosaurs appealing, they will be drawn to [the DinoLab] exhibits over others." In the DinoLab exhibit guests are able to watch and interact with real paleontologists. "How many places can you go watch real dinosaur bones coming together and ask the paleontologist working on them anything you want?" asks Christopher. There is also a digging quarry where children can brush aside small pellets of rubber that look like dirt to uncover dinosaur bones (see Figure 20).

**Conclusion.** The Science City case study has featured design values used by Matt Christopher when developing exhibits for the Science City science center. The design values highlighted include cost, durability and safety, degree of multisensory engagement, alignment to state curriculum, and aesthetics that are congruent with an environment theme. The following represents other assertions about Science City and the values used by Christopher.

*Figure 20.* The digging quarry at the DinoLab exhibition area at Science City.

Christopher seemed to be more focused on the cost, durability, maintainability, and look of the exhibits and less on the content or purpose of the exhibit. Cost was particularly key for Christopher. Without the money projects are unable to move forward. It is also possible that Christopher is responsible for the maintenance of the exhibits. One who is responsible for maintaining an exhibit would likely be more interested in how solidly it is put together and less interested in the content or subject matter.

Use of staff on the floor is particularly beneficial, but is equally challenging to provide due to costs. As noted earlier the DinoLab is a space where paleontologists are able to interact with guests. Christopher shares,

> As with all fossil prep lab exhibits though, budget issues get solved by dumping staff, which reallocates the remaining staff to more necessary activities than preparing fossils,

like taking tickets, scheduling staff, writing grant applications, and all the other things those 9-out-of-10 staff used to do before they were eliminated.

Limited budget has also increased the amount of responsibilities for Christopher. Science City has had to dramatically reduce the number of staff since they first opened in 1999. It is likely that Christopher has had less time to design additional exhibits due to other obligations with organizing educational classes and activities, doing paleontological work, maintaining the exhibits, managing other staff members, etc.

There could have been more insights obtained by Christopher had the interview not been structured and done over email. It was found that the structured questions were limiting. Interviews conducted with the other exhibit developers in the other cases were all done real-time, meaning the interview questions became adaptable as responses were given. Additionally, there was less data collected from the text-based interview than had it been over-the-phone or in person. This is a result of the nature of the type of interview that Christopher was able to participate in.

## Multiple Case Study Analysis

In the preceding section four different cases were presented: The Boston Children's Museum, The Children's Museum of Pittsburgh, The Children's Museum of Houston, and Science City which is a part of Union Station Kansas City. The following section represents a multiple case study analysis that has been conducted as described by Stake (2006) to compare and contrast the various cases. I took "evidence from the case studies to show how uniformity or disparity characterizes the" differing museums, their developers, and the design values used by those developers (Stake, 2006, p. 40). Ideally insights about the similarities and differences among exhibit developers and their museums can be used as a model to inform future design decisions.

### Emphasis on Family Learning

Three of the four museums have family learning or family interaction as one of the main design values that they follow when developing children's museum exhibits. These three, the Boston Children's Museum, the Children's Museum of Pittsburgh, and the Children's Museum of Houston are all officially considered children's museums. While Science City has attributes of a children's museum, perhaps designing for families is not such an important thing for them, because it is a science center. It could be assumed that if a museum is a children's museum then they would have exhibits that are applicable for entire families, regardless of the age group.

The three official children's museums each had exhibits that highlighted the use of family learning as a design value. They all influence family interaction; however, each of the exhibits did it in a unique way. For example, Johnny's Workbench at the Boston Children's Museum encourages meaningful family interaction by challenging children to build a sailboat. The activity is difficult enough that young children are unable to complete it on their own. Help from

another person, preferably a parent is needed. Additionally, hearkening to Boston's seafaring heritage promotes meaningful family conversations, particularly about family history.

The Studio at the Children's Museum of Pittsburgh gets family participating in art activities, either together or in the same room. The Studio is appealing for all age groups, because of the multiple entry points that are naturally built into art activities. A child could be painting a simple flower next to his or her parent who is painting a rich, diverse landscape.

At the Children's Museum of Houston Cyberchase seeks to involve parents in the child's learning at the museum and at home. In this exhibit guests practice solving math challenges to accomplish a goal. Parents are encouraged to get involved through the use of "clues" that are posted throughout the room. Also, parents and children can take worksheets home with them to help facilitate the learning away from the museum.

Not all of exhibits encourage family learning using different methods. Consider the Building Zone at the Children's Museum of Houston. In the exhibition are two exhibits that are challenging enough that they are difficult for children to do it by themselves. One is the arch building exhibit; the other is the Clubhouse Design exhibit. These exhibits are similar to Johnny's Workbench, in that children usually need the help of a parent to successfully complete the activity.

In Welcome to Mister Rogers' Neighborhood at the Children's Museum of Pittsburgh parents are able to converse with their children about their experiences watching *Mister Rogers' Neighborhood*. This involves talking about family traditions. This is similar to Johnny's Workbench, because of the opportunities for parents to talk about Bostonian heritage. In both of these exhibits families are provided with conversation topics between children and parents.

**Physical Interaction with Exhibits**

Almost all of the exhibits at the museums are hands-on or touchable. The tangible nature of the exhibits invites visitors to experiment and make their own discoveries. It also allows children to learn through play.

The developers at the various museums used differing terms to refer to the same or similar types of design values. Durrell, from the Boston Children's Museum, often spoke about physical engagement, which he described as, "Touch…[meaning] touching things and moving things around." However, Fullenkamp, from the Children's Museum of Pittsburgh, calls it hands-on, or playing with real stuff. Christopher at Science City talks about multisensory exhibits, touch being one of those senses.

**Facilitation Through Museum Staff or Volunteers**

The importance of staff or volunteer facilitation was made clear in several of the cases. Durrell spoke about designing with the facilitator in mind. One of the reasons that the Investigate exhibit at the Boston Children's Museum is so successful is because of the educator that is often there, helping to facilitate meaningful conversations. Ostfeld mentioned that the actual exhibit is only one part of a much larger picture. Special programming, which would include additional facilitation from a volunteer or staff member, becomes the norm for many of the exhibits at the Children's Museum of Houston. In fact the standard experience, in many cases, requires interaction with a facilitator.

**Tradeoff Between Creativity and Functionality**

There seemed to be some differences among the museums when deciding between functionality and creativity. Christopher focused very heavily on the cost, durability, and maintainability, which are all aspects that help with the functionality of an exhibit. This could be

due to the budget restraints at Science City. For example, he stated that they would not build an exhibit unless they could build it out of scrap materials that they already had, and then it had to withstand a great deal of physical strain before it would be acceptable. Cost and durability were the two most important design values according to Christopher.

While the other museums focused on durability and functionality also, they seemed to be more focused on the content and creativity of the actual piece. They often considered creative ways of involving both children and parents in the learning process. Not one of the other three museums mentioned durability or functionality as their first two values. For Durrell it was family learning and physical engagement; Fullenkamp said it was multiple entry points and playing with real stuff; and for Ostfeld it was family learning and DEEP. Focusing on these values first allows for greater creativity. That is not to say that focusing on cost and durability prevents one from being creative, but focusing first on mere functionality certainly possesses more restraints than the values placed first at the other three museums.

**Implementation of Multiple Design Values**

The most successful and popular exhibits at all of the museums were always influenced by not just one design value, but by many. The following are examples of exhibits from each museum that were developed with multiple design values in mind:

**Johnny's Workbench.** Johnny's Workbench at the Boston Children's Museum is challenging enough for a young child that they often need help from a parent, thus family learning is a central component. This exhibit also requires the use of physical engagement with tools and material to create a sailboat.

**The Studio.** The Studio at the Children's Museum of Pittsburgh also puts family learning as a central feature of the space. However, this area in the museum allows visitors of all

backgrounds to participate at the level that they are at, thus involving multiple entry points. Lastly, The Studio allows for visitors to play with real stuff, including real paint, real pottery, and real silk screening.

**Clubhouse Design.** As with most of the other exhibits at the Children's Museum of Houston, Clubhouse Design was created with family learning as the central design value. Signs are posted which encourage parents to interact with their children, and some of the activities are difficult enough that children will need help from their parents. The exhibit is also very simple. Visitors are allowed to build anything they would like to. The pieces they work with are very intuitive. Guests are given flat pieces of wood with notches in them that allow the pieces to be interconnected like Lincoln Logs. Simple instructions teach parents and children how to complete the activity.

**Music Park.** Music Park at Science City is an exhibit that is extremely durable. Day after day it receives an intense amount of beating. It was built to withstand rigorous play from both children and adults. Additionally, Music Park is multisensory. It involves the senses of touch and hearing. Lastly, it fits into the larger Science City theming, because it is a park within a city.

**Differing Areas of Expertise Among Developers**

It was observed that each of the exhibit developers had a different viewpoint when explaining their design values. It is likely that their various backgrounds have influenced the way they think of design. For example:

Durrell started his career as a furniture designer. He is able to physically build components of the exhibit. Because he has always been physically engaged with building during his career, he has placed a great deal of emphasis on it for the children and parents who come to

the Boston Children's Museum. His design values seemed to be much more fluid and open than the others, doing what seemed best in each circumstance. For him it might be said that design is more like an art and less like a science.

Fullenkamp's background is in architecture. She is able to understand how components of an exhibit should fit together both visually and physically. She can also be a proponent for playing with real stuff, because as an architect she is able to understand how objects are built; she knows when the museums would need to compromise on using real stuff with other fabricated materials. The design values used by Fullenkamp were much more systematic. This could be a reflection of the museum she works for. Perhaps there is a set design protocol that she and other designers are supposed to follow when coming up with exhibit ideas.

Ostfeld began his career as an educator. His past experiences have allowed him to help create exhibits that can be utilized not only by the visitors but also by the on-floor educators, be they volunteers or staff. The Children's Museum of Houston is known for its special programming, which helps bring in additional education features to each of the exhibits. Ostfeld's educational background allows him to meaningfully contribute to creating multi-purpose exhibits that can be stand-alone or enhanced through facilitation. Ostfeld's design values were very structured. He referred frequently to the set values that are used by the entire design staff when designing new exhibits.

Christopher is a paleontologist who was hired on at Science City to help with paleontological programming and fossil preparation and replication. His past experiences would have granted him opportunities to work with his hands, thus helping him to know how to build exhibits that are durable and functional. Additionally his educational background has also helped him know how to align the exhibits at Science City with state educational objectives.

Christopher’s design values were also very systematic, and they were determined largely by the available budget.

## Conclusion

The first purpose of this study was to identify the design values that were used by expert exhibit developers at various children's museums to create successful exhibits. These values are their ideals which guide them in their design. They are aspects developers deem to be important in each exhibit. The second purpose of the study was to observe how exhibit developers prioritize these values. The final purpose of the study was to identify the desirable outcomes that developers wanted guests to experience as a result of interacting with the exhibits. The following paragraphs will seek to draw connections between the three purposes of the study. First, family learning will be discussed as an overarching central design value for most of the developers; when prioritizing their design values, many developers chose this as their most or one of their most important values. Other secondary design values that contribute to the value of family learning will also be identified and discussed. Next, the issue of prioritizing design values will be addressed. Finally, meaningful family interaction that empowers visitors of all ages will be discussed as a primary desirable outcome sought for by the developers.

### Family Learning as a Central Design Value

Of all the values used by the various exhibit developers, family learning tended to be the most prominent. According to Dierking (2011a), "Family learning is playful, fun, and a social experience," and is often observed when family members are engaged in conversation with one another. In the literature review it was noted that family learning has recently become a major focus of many museums, particularly children's museums. In this study it was observed that most of the developers interviewed created exhibits with family learning as a central design value.

This central design value of family learning contributed to a major desirable outcome for the exhibit developers, which was the desire for family members to interact with one another in meaningful ways. Exhibits created by these exhibit developers promoted family interactions and were appealing for family members of all ages. An exhibit that is designed with family learning as the central design value may take on certain unique characteristics, such as encouraging family members of all ages to interact with the exhibit and one another. An exhibit that promotes learning for the whole family may have text for adults, graphical representations for children, and parts and pieces that can be manipulated by all age groups. It may require family members to work together to accomplish some sort of objective, such as solving a problem or building an object; or it may invite them to continue their exploration of a topic at home. An exhibit that is designed with family learning will encourage parents and children to interact with one another in meaningful conversations.

Based on the findings of this study there are additional, secondary values, along with broadly focusing on the central value of family learning, which will help other exhibit developers create family-oriented exhibits. As far as I have been able to observe, there are no other references that discuss the design values in context to specific exhibits in the way that has been done in this study. Thus these values could also be incorporated by other museums that promote family values to either strengthen the exhibits they already have or to create new, meaningful ones. The following paragraphs will demonstrate how some of the secondary design values identified by the exhibit developers in this study can contribute to meaningful family interactions in children's museums. The values discussed are similar to those identified by Borun and Dritsas (1997) when they noted that an exhibit that focuses on family learning should be multi-sided,

multi-user, accessible, multi-outcome, multi-modal, readable, and relevant; however, as will be observed, their principles and the values discussed below are not identical.

**Drawing on past experiences.** Exhibits can benefit families when they help family members draw on past experiences that they have had with one another. Throughout many of the museums featured in this study, guests can find signage that prompts parents to engage in conversations with their children. Oftentimes a sign may encourage parents to liken what is happening in the museum to activities that happen at home. Exhibits themselves can also provide families with talking points too. As was discussed earlier, Johnny's Workbench hearkens back to Bostonian heritage perhaps as a way for families to talk about what it means to grow up in Boston.

**Having multiple entry points.** Exhibits that are designed with multiple entry points allow for family members of all ages and backgrounds to participate. Multiple entry points is more than providing physical access to the exhibit to several people, it also involves using content and design features that are interesting and applicable for all audience members, regardless of age. Fullenkamp spoke about the Studio and Garage Workshop tinker room as examples of multiple entry points. A family that has children and parents with several different interests and involvement levels can participate meaningfully in the various experiences that are available at those exhibits.

**Creating challenging exhibits.** Exhibits that are physically, mentally, or emotionally challenging can often promote family learning. If parents notice that their child is having a difficult time accomplishing an objective of an exhibit, they have three primary options: They can move on to the next exhibit, perform the functions of the exhibit themselves, or help their child accomplish the objective. More than likely they will strive to help their child. Helping a

child can come in a number of ways. It may involve helping a child to lift a heavy object, such as the boards in Clubhouse Design at the Children's Museum of Houston; it could include coaching them through a challenging problem, such as encouraging a child as he or she climbs the New Balance Climb exhibit at the Boston Children's Museum; or it could involve cooperatively working together on a task that is impossible to accomplish individually, such as putting the arch together in the Building Zone at the Children's Museum of Houston.

**Providing staff or volunteer facilitation.** Staff or volunteers can help engage family members through facilitation or other educational programming. Ideally an on-floor facilitator will not only tell families how to interact with exhibits, but will encourage family members to think through problems together, will show them how to work together to accomplish a goal, or will provide the parents with other ways to get involved with their children at the museum.

**Creating hands-on exhibits.** Exhibits that are hands-on provide all guests, regardless of age, opportunities to interact with the exhibit. At a more traditional museum most exhibits will be for display only. Children, especially those that are young, may have a difficult time staying engaged in these museums because of their smaller attention spans. At a hands-on museum, both adults and children can get involved and become participants in the learning process. When all members of a family are involved there is more likelihood that a meaningful interaction between the family members will take place.

**Focusing on open- and close-ended outcomes.** Both exhibits that are open-ended and those that are close-ended can encourage family learning; however, open-ended exhibits likely encourage family learning more so than close-ended exhibits. Exhibits that are open-ended allow for a variety of objectives to be met, visitors can be engaged in many different activities at one exhibit, and often open-ended exhibits allow the guests to use more creativity in their

interactions with each other and the exhibits. These findings are similar to those discussed in the literature review. Namely, open-ended exhibits are similar to the Advanced Prolonged Engagement exhibits created at the Exploratorium in San Francisco, which encouraged visitors to draw their own conclusions, build their own models, and lead their own scientific inquiries (Humphrey & Gutwill, 2005). Additionally Pekarik (2010) also emphasized that the potential for learning could be increased when exhibits are designed to be open-ended. Examples of open-ended exhibits in this study include The Studio and Garage Workshop tinker room at the Children's Museum of Pittsburgh, Clubhouse Design at the Children's Museum of Houston, Bubbles and Raceways at the Boston Children's Museum, and the Thoughts Flow water table at Science City at Union Station Kansas City.

Exhibits that are close-ended can also promote family learning among museum visitors; however, there are not as many notable examples. Johnny's Workbench at the Boston Children's Museum is an example of an exhibit that had a single purpose: build a sailboat that looks like all the others. However, this exhibit allowed for parents and children to work together to accomplish a difficult task and provided them with content for meaningful conversations.

**Creating immersive environments.** Showcasing exhibits in an immersive environment can help families more readily engage in learning. Immersive environments rich with theming, to some extent, allow for visitors become immersed in playful learning. Discovering and investigating become natural in these settings. Guests do not need to wonder what they are supposed to do at an exhibition. Because of the setting, guests feel encouraged to participate in the various exhibits. Parents and children may feel a natural inclination to participate in immersive experiences more readily than they would stand-alone exhibits.

**Prioritization of Design Values**

The second purpose of the study was to observe in what ways the developers prioritized their design values. It was seen that for the most part the priority placed on each design value was dependent on the developer, his or her background, and purpose of the exhibit. For instance, Durrell at the Boston Children's Museum said that the values work "hand-in-hand," meaning there was not one value that was more important than another. Instead, he considers "what needs to be in the exhibit, who is the exhibit going to serve, and what's the best way to make that happen?" However, as a result of his design and building background he placed a lot of emphasis on the design value of physical engagement as a means to promote family interactions.

For Fullenkamp, an exhibit could not be successful unless it was "first and foremost" functional, meaning the exhibit needs to work both physically and conceptually. However, when it was assumed that the exhibit would be functional, other design values became more important such as designing to have multiple entry points and playing with real stuff. It was also seen that while playing with real stuff was important, particularly for Fullenkamp who has a background in architecture, she and the other designers at the Children's Museum of Pittsburgh were willing to compromise on real stuff to meet the objectives of a particular exhibit. Again, as with Durrell, it was observed that the priority of the design values is situational depending on the exhibit.

Ostfeld, at the Children's Museum of Houston, did not give much feedback on the prioritization of design values, except to say that family learning is at the center and the other values are based off of it. However, the emphasis that Ostfeld placed on educational programming throughout the museum seems to coincide with his background as an educator.

At Science City Christopher prioritized his values as "cost, durability, [safety,]…degree of multisensory engagement, alignment to state education curriculum points, aesthetics and

[congruence] within environment theme." Unfortunately Christopher did not expound beyond that. It is likely that the priority placed on each design value is determined largely by the budget at Science City.

**Desirable Outcomes**

Because family learning is such an important design value for most of the developers, it is understandable that the primary desirable outcome for most developers and their corresponding children's museums is to have parents and children interacting with one another in meaningful ways. According to Durrell, this interaction often leads to empowerment, particularly for the children. For Fullenkamp, she desired for family members of all ages to get involved in a way that would lead to quality family time at the museum and repeat visits. This means the parents need to be engaged as much as the children. Ostfeld said, "One of the most important pieces is that you have got to have family interaction." For him this means getting both the adults and children engaged with the exhibits. Ostfeld also felt that empowerment was important, particularly through helping children take part in the decision-making process. Christopher also desires for families to spend more time together interacting with exhibits. He seeks to accomplish this by relating the exhibit subject matter to familiar contexts. Then a "positive interaction between [the parents and children occur] as they leave the exhibit, discussing what they just experienced," says Christopher. Each of the developers recognized the importance of parents and children interacting with one another. They likely see this as a way to help families participate in informal learning onsite and beyond the walls of their museums.

**Final Thoughts**

It is hoped that readers are able to transfer insights that they gained from reading this thesis into their own practices or into further research. This report is in no way the

consummation of knowledge about the development of successful exhibits at children's museums. Each of these museums could be looked at further. Other museums and developers could also be used as further research subjects to learn more about this topic. They would certainly have additional insights to add to this pool of knowledge.

These museums and their respective developers understood the importance of engaging not just the children, but the parents as well. And hopefully the two parties are not solitarily engaged with exhibits. It is hoped that the parents are interacting with their children and that both groups are learning from one another. These museums have the unique opportunity of creating lasting experiences that will strengthen the familial bonds that exist between family members, both while at the museum and at home.

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# Appendix

The following protocol will be used to guide the interviews with exhibit developers.

**Interview Questions for Exhibit Developers**

*Note:* These surveys will be semi-structured. As a result, probing questions will be asked that are not listed here. Additionally, because this is qualitative research, the themes of the questions in successive interviews will likely change as data is collected and analyzed.

1. What is your name?
2. What is your position at the museum?
3. How long have you worked there?
4. What academic and work experiences have you had that led you to this point in your career?
5. What design values do you use when you design and develop children's museum exhibits for your museum?
6. How would you prioritize your design values?
7. Why is design value A more important than design value B?
8. What other factors contribute to making a successful children's exhibit?
9. Can you think of specific exhibits that you have helped develop that exemplify these design values?
10. Tell me how design value A influenced the development of exhibit Z.
11. How do you create an exhibit that engages both children and parents in learning activities and has an element of fun?
12. When you develop new exhibits, what desirable outcomes do you strive to achieve with the guests?

13. If an exhibit is supposed to be designed for children and parents, how can it be meaningful for both, and how can one know if it is?
14. How do you know when you have created a successful children's museum exhibit?
15. What causes some exhibits to be successful and others to fail?
16. Why are families attracted to some exhibits and not others?
17. What is the most popular exhibit at your museum and why?
18. What is your favorite exhibit at your museum and why?
19. Do you have other suggestions or ideas that would help me to know how to design a great children's museum exhibit?
20. Do you have additional documents (including design documents) or references that would help me with my research?