Summative Evaluation of

Star Wars*: *Where Science Meets Imagination
Museum of Science, Boston

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Members of the exhibition team include the following:

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EXECUTIVE SUMMARY

Star Wars: Where Science Meets Imagination is a National Science Foundation funded project which developed a national traveling exhibition on science and technology themes depicted in the *Star Wars* movies. The Museum of Science, Boston (MOS) developed the exhibition in collaboration with Lucasfilm Ltd. and Science Museum Exhibit Collaborative (SMEC). The exhibition will travel to members of the SMEC in Los Angeles, Portland, Fort Worth, St. Paul, Columbus, Philadelphia, and Boston. Other venues will display the exhibition after the Collaborative tour. Tisdal Consulting was contracted to conduct remedial and summative evaluation studies to assess the strengths and weaknesses of the exhibition at its first two venues: the Museum of Science (MOS), Boston, and the Columbus Ohio Science Center (COSI). The exhibition opened at MOS on October 27, 2005. A remedial evaluation report was submitted on February 1, 2006 based on data collected between November 4 and 20, 2005. The purpose of this summative study is to provide information to allow the exhibition team, SMEC, and funders to decide if the exhibition accomplished its intended outcomes. Findings will also be useful to other institutions hosting the traveling exhibition. We used a naturalistic methodology to conduct the study using both qualitative and quantitative methods to collect data at MOS between April 1 and April 13, 2006 and at COSI between July 8 and July 22, 2006.
Summary of Audience of the Exhibition

Findings

Audience of the Exhibition

One of several aims of the *Star Wars* exhibition was to use the popularity of the *Star Wars* films to attract a wide range of visitors, not just those interested in science and technology, and not just fans of the movies. New and infrequent visitors were a specific target audience. In many ways the exhibition successfully accomplished these goals. The strategy also had some unintended impacts. The audience of the exhibition at its first two venues was consistent and showed a limited range. But we found some diversity behind the numbers that showed a greater range than the quantitative trends might indicate.

Based solely on demographics at its first two venues, the *Star Wars* exhibition attracted consistent, but somewhat narrow profiles of visitors. This profile is somewhat consistent with the profiles of science center in other studies. Overall, this audience was comprised of about 65.0% of *adults visiting in groups with children* under 18 years old, about 25.0% came in *adult only group*, and about 10.0% visiting alone. Compared to the U.S. population, this audience was very well-educated, and with higher-than-average levels of household. In terms of ethnicity, about 84.0% identified themselves as white, 7.0% as Asian American, and 9.0% as Hispanic or Latino. The exhibition attracted a fairly balanced number of males and females. Males were about 55.0% of the audience and females about 45.0%

The exhibition was quite effective in prompting visits, particularly among infrequent visitors. Over 75.0% of respondents reported coming to the site that day specifically to see the *Star Wars* exhibition. About 50.0% of the audiences across sites were infrequent visitors. This is a much higher level of infrequent visitors than those attracted to other special exhibitions at MOS.

Within the qualitative data, we found patterns that indicated that the exhibition was successful in attracting some atypical science center and science museum visitors than it would first appear by looking at the numbers alone. We identified some groups who came to the exhibition with very different meaning orientations toward the *Star Wars* films. Typical science museum and science center visitors appeared more frequently among some of these groups than others.

Among a few visitors, we found a meaning orientation we called *Star Wars Indifferent*. These visitors had accompanied someone else to the exhibition and had very little interest in the films or in science and technology. We identified another group, *Star Wars Explorers*, who were familiar with the films but did not identify intensely with either the action/adventure technology themes or the narrative elements. Among another group, *Star Wars Adventurers*, we found people who identified with the action/adventure technology elements of the films. These visitors had high to intense levels of interest in the films. Finally, among *Star Wars Epic* fans we found high to very intense identification with the narrative elements of the films, including characters and the epic struggle between good and evil.

Other audience characteristics have relevance to how people used the exhibition. These are social roles visitors brought with them into the experience. They are more than simple exhibit-based behaviors. Visitors we classified into a group called *Somebody Else's Visit* were focused but not highly involved with the visit of a friend or spouse. These were generally adult visitors with another adult. Some visitors played a role we called *Group Monitor*. Despite their own personal orientation to the films, these visitors focused their efforts on other group members' visits. Members of this group were often parents with children. More mothers played this role than fathers. Another group of respondents we named *Learning Monitors*. These visitors, both mothers and fathers, watched and assisted children in learning and facilitated their enjoyment of the exhibit. These respondents were more likely to have engaged at exhibits with children than were *Group Monitors*. Finally, we identified a group of *Primary Visitors*. These individuals were focused on their own experiences. Most children fell into this group, and most members of *adult only* groups. *Primary Visitors* also interacted with others and influenced each other's experiences.

All these audience characteristics provide frameworks for understanding how people engaged with and were impacted by the exhibition experience. The large numbers of visitors attracted to the *Star Wars* exhibition influenced a central contextual factor that affected engagement and learning.

Engagement

Findings on engagement allow the exhibition design team to judge whether exhibit strategies and elements functioned as intended and expected. Along with audience characteristics, it provides a framework through which to understand the level and nature of outcomes and impacts.

High Level Picture of Engagement

In terms of high level indicators, *Star Wars* was an *exceptionally thoroughly used exhibition.* We based this finding on Serrell's (1998) standardized indicators, percentage of diligent visitors (*DV%*) and sweep rate index (*SWI).* The exhibition showed remarkably consistent performance across sites. Respondents stayed and average of 62.3 minutes in the exhibition. At least 50.0% stayed 54.0 minutes. Respondents stopped at an average of 18.4 exhibit elements with 50.0%

stopping at least 19 exhibit elements. (There were 37 exhibition elements in the gallery at MOS, and 38 at COSI where *Millennium Falcon* was included in the ticket price and included in the main gallery space.) There were some small numerical differences. Younger visitors stayed an average of 5 minutes longer. Respondents in *groups with children under 18* used fewer exhibit elements, an average of 17, compared to *adult only groups*. We attribute both these differences to how different groups used interactives. Across group types, adults gave priority to children using interactives.

We also considered the levels of attraction and holding of specific exhibit elements, and the pathways visitors took through the exhibition. Different types of exhibits can be expected to attract and hold at relatively higher and lower levels. We identified several artifact displays which could be expected to attract large numbers of visitors, and this expectation was met. These exhibits also had substantial holding times. This appeared to be due to video elements featuring interviews with *Star Wars* movie makers that held visitors' attention. We found that the two *EDLs*, designed as important anchors of the two thematic areas, had relatively high levels of attraction and substantial holding times. In addition, we found no primary pathway apart from visitors entering into the transportation theme area and exiting from the robotics theme area. Some visitors, particularly older people and those with disabilities, wanted an overview of the spatial and thematic organization so they could make clearer choices about how to spend their time and move through the exhibit space.

A Focused Look at Areas of Engagement

Due to the popularity of the exhibition, waiting in line and crowds were central features of many visitors' experiences. Lines were associated with the two timed presentations, *2.02 Robot Theater* and *Millennium Falcon*. At MOS, with only one of these elements in the exhibition space, visitors spent an average of three minutes waiting in line. At COSI, the average wait was much higher, 13 minutes. In addition, many visitors chose not to go to these presentations because they did not wish to wait in line.

Crowding affected engagement at all interactives but particularly at the two *EDLs*. These important multi-station interactives were designed to provide central anchor experiences for each theme area. They also gave visitors the opportunity to actually do the entire engineering design process and understand the importance of each step. Many children used the *EDLs* and had good experiences with substantial engagement and using more than one station. Many adults gave priority to children's engagement and did not participate in these areas.

A Close-Up View of Engagement

For a close up view of engagement, we use vignettes to tell the stories of three visiting groups with a range of engagement. These vignettes focused on the experiences of three groups that we named *Michigan Tourists*, *Cleveland Daytrippers*, and *Boston Locals*. These stories illustrate the large number of factors that influenced the level of engagement in any group of visitors. *Michigan Tourists*, a family group with older children and scientifically confident parents, illustrate a very high level of engagement. These *Star Wars Adventurers* stayed over two hours and used a wide range of exhibits. They were experienced museum-goers and planned their visit for a Monday when they expected the space to be less crowded. *Cleveland Daytrippers* tells the story of a single mother and her 9-year-old son who both had a low level of engagement. Both

were *Star Wars Epic* fans. The two were infrequent visitors to cultural institutions and chose to visit on a busy Saturday. The mother had planned the trip from website information and expected more artifacts and visual displays and less science and technology. The mother's lack of confidence in her own scientific and technology capabilities frustrated her attempts to be a *Learning Guide* for her son's experience. They visited under an hour after a 2 ½ drive to see the exhibit. At a moderate level of engagement, the *Boston Locals* were an adult dating couple in their forties. She was a *Star Wars Epic Fan* and he was a *Star Wars Adventurer*. They had planned this visit for several months to celebrate her birthday, and chose a less crowded weekday because of ticket availability. While they claimed to be interested only in the film artifacts, they watched videos and used some of the interactives.

These various views provide a picture of engagement in the *Star Wars* exhibition. Compared to other exhibits it was *exceptionally thoroughly used*. But, groups of visitors made different decisions about what elements of the exhibit to use. Some of these choices were influenced by their meaning orientation to the *Star Wars* films, composition of the visiting group, age level of children, expectations about the experience, and social roles. Choices were also influenced by the level of crowding and an overall audience mix with large numbers of children.

Outcomes and Impacts

In structured exit surveys we found consistently high satisfaction ratings across locations and groups. The overall satisfaction rating, with 1 = *Low* and 4 = *High*, was an average of 3.7. Respondents with higher levels of interest in and knowledge of science and technology rated their satisfaction even higher. But this relationship was at a moderate level. Most, but not all, people who went to the exhibition reported being highly satisfied.

In in-depth interviews we got a deeper understanding of what factors contributed to and detracted from satisfaction. Among most respondents, an important ingredient of their satisfaction was the *Star Wars* theme and the excitement and intensity of attending a big exhibition with many other people. Costumes and artifacts contributed to satisfaction, along with the opportunity to share the occasion with family and friends. Both adults and children valued the opportunity to engage in interactives and learn things about science and technology. The biggest factor detracting from satisfaction was crowding.

For some respondents, we found an expectation of more *Star Wars* artifacts and less science and technology. We found more of these comments at COSI than at MOS, and we attentively concluded this may have been due to marketing messages. We attributed this to the attractiveness of the exhibition to both *Star Wars Adventurers* and *Star Wars Epic Fans*. *Star Wars Adventurers* were more likely to make the connection between their own meaning orientation and the science and technology themes in the exhibition. *Star Wars Adventurers* were more likely to mention the differences between their expectations and the experience and still be quite satisfied. Adult *Star Wars Epic Fans* who had expected a more artifacts-based experience focused on the characters and themes were the most likely to be less satisfied with their experiences. Very few respondents interviewed were dissatisfied. Another factor that contributed to levels of satisfaction was crowding. On less crowded days, all types of visitors appeared more satisfied.

We found that respondents understood our question about the *Big Idea* of the exhibition in two ways. First, "What do you think the designers of the exhibition intended you to get from the exhibition?" Second, "What did you intend to get out of coming to the exhibition?" The exhibit design teams defined their *Big Idea* for exhibition as "you can have fun using technology skills to design a future, like the *Star Wars* Universe." (Museum of Science, 2005A, p. 17) In the final analysis, we would estimate that more than half of the visitors to the exhibition understood the *Big Idea* of the exhibition, and a substantial number understood part of it. Our quantitative findings about the *Big Idea* of the exhibition do not provide a clear, unambiguous answer to the question "To what extent did visitors get the Big Idea of the exhibition?" We can say that only about 16.9% of the respondents to the exit survey appeared to make no connections to the science and technology content of the exhibition, about 40.3% made at least one content connection, 33.8% made at least two content connections, and 9.1% made three content connections.

In in-depth interviews, we found that some visitors clearly understood the intended *Big Idea* of the exhibition, but did not embrace it as their own. We also found some respondents who never fully comprehended the *Big Idea* of the exhibition. These visitors tended to come with clear expectations that the exhibition was about *Star Wars* artifacts. In other cases they expected the exhibition to be about *Star Wars* special effects or technology. These respondents never made the explicit connection between *Star Wars* technologies and real-world technologies. We identified more of these respondents at COSI, and we associated this with the focus of marketing materials on *Star Wars* characters and images. Another influence could have been the previous *Star Wars* exhibition focusing on special effects.

There were five primary messages and sets of learning goals focused on adults. In general we found respondents appeared to have the clearest understanding of the role of imagination and creativity in technology design. Second in overall strength was the idea that there are current, real-world technologies similar to those in the *Star Wars* films. At somewhat lower levels of understanding were the importance of knowing about scientific phenomena in technological design and the importance of understanding trade-offs in making decisions about new technologies. Lowest in strength of these five messages were concepts about the engineering design process and the extent to which visitors felt empowered to actually give it a try. The strongest area of impact for adults was real-world technologies.

Among children the role of imagination and creativity from the exhibition was also very strong. But they were much more likely to have both engaged in the engineering design process and have made clear connections to it based on the exhibition experience. Based on age level, we surveyed children who had engaged at either of the two *EDLs*. This experience had either reinforced their existing knowledge or made connections to the process as a whole. We also found numerous connections to both *Star Wars* and real-world technologies among children's pictures. But there was also evidence that some children, particularly in younger ages groups, focused on the narrative elements of the experience. But, even among groups where parents had relatively little science and technology expertise, we found surprising numbers of connections to science and technology careers among children above about 7 years old.

Accessibility

Overall, the universal design features appeared to increase the enjoyment and learning from the exhibition for most respondents with disabilities. The exhibition worked best for people who were deaf and those who used wheelchairs. Respondents with low vision and those who were blind had the greatest challenges. We also found that the exhibition worked somewhat better at COSI than at MOS, due to higher overall light levels and more space between exhibit elements. In addition, the revised audio systems at COSI were easier to find and less confusing. We found that at both locations financial accessibility was an issue for people with disabilities. We believe that this concern deserves consideration by institutions, funders, and other interested parties. Overall, we found the accessibility efforts in the *Star Wars* successful in improving the experience.

Conclusions

Two popular culture terms best describe what we learned about the overall effectiveness of the *Star Wars* exhibition, *state-of-the-art* and *pushing-the-envelope*. *State-of-the-art* encapsulates the success of the exhibition in providing a highly satisfying experience for many visitors. It also captures well the success in providing many rich informal learning experiences with evidence that many visitors accomplished intended goals. We also found evidence of potential impact beyond the visiting experience. *State-of-the-art* also describes how the exhibition was created. At its inception the exhibition was connected to important national issues in technology literacy. Based on the informal science education field's success in making learning fun and relevant, a popular theme was selected to attract new and infrequent visitors to informal science learning institutions. Front-end analysis and evaluation was conducted to understand what visitors found attractive and relevant. The design team developed an explicit learning rationale based on theory with clear strategies, well-stated goals, and clear messages. Types of exhibit experiences were carefully considered based on previous research and evaluation and best practices.

Pushing-the-envelope describes taking on a complex process such as engineering design and carefully designing and prototyping multi-station areas. At this point in time, this exhibition is highly effective, *state-of-the-art*, and *pushing-the-envelope* in our understanding of what can be accomplished in prolonged deeply engaging exhibits. Among respondents who had access to this experience, primarily children and a few adults, we found clear connections to engineering and age-appropriate articulations of the process. The *EDLs* pushed the envelope and the challenge was largely met. Another way the exhibition pushes the envelope is by using universal design features to make the experience more accessible to people with disabilities. Using these two overarching measures and based on the findings of this study, *Star War: Where Science Meets the Imagination* is a highly successful exhibition. To a great extent and for many people the exhibition accomplished many of the intended outcomes and impacts.

These two terms also encapsulate the exhibition's limitations. In this study, the experience in *Star Wars* was *state-of-the-art* in that, like other popular exhibitions, its ability to attract visitors and the levels of crowding resulted, at times, in overwhelming the capacity for rich, satisfying learning. The exhibition is also *state-of-art* in terms of the limited range of the audience it attracts and serves. Over the past 25 to 30 years, many museums have become fee-based institutions. We concluded that the demographics of the *Star Wars* audience were largely

influenced by the ticket price. Interviews with people with disabilities provided evidence that ticket prices are a barrier to this group.

Providing opportunities for learning and enjoyment within the same time and space for both adults and children is a major challenge among science museums and science centers. The field as a whole needs to continue to find ways to serve both audiences. It may or may not be possible to do this in the same space at the same time.

Finally, the efforts to attract visitors to the exhibition were *state-of-the art*. We heard numerous mentions from visitors of media sources including television, radio, newspapers, websites, and travel magazines. The distances respondents traveled indicated the broad reach of these methods, and the crowds proved their effectiveness. But we did find some disconnect between the expectations of the respondents and the experience they found. The degree of disconnect we identified affected satisfaction to some extent and may have influenced engagement, particularly among some infrequent and new visitors.

In summary, given what we know about informal science learning and the tools we have right now, *Star Wars* was a highly successful product which combined knowledge and expertise into a highly satisfying and rich learning experience. As the informal science education field progresses, learning from important exhibitions such as this will further our understanding of creating enjoyable and deeply meaningful learning experiences.

INTRODUCTION

Star Wars: Where Science Meets Imagination is a National Science Foundation funded project which developed a national traveling exhibition on science and technology themes depicted in the *Star Wars* movies. The Museum of Science, Boston (MOS) developed the exhibition in collaboration with Lucasfilm Ltd. and Science Museum Exhibit Collaborative (SMEC). The exhibition will travel to members of the SMEC in Los Angeles, Portland, Fort Worth, St. Paul, Columbus, Philadelphia, and Boston. Other venues will display the exhibition after the Collaborative tour. Tisdal Consulting was contracted to conduct remedial and summative evaluation studies to assess the strengths and weaknesses of the exhibition at its first two venues: the Museum of Science (MOS), Boston, and the Columbus Ohio Science Center (COSI). The exhibition opened at MOS on October 27, 2005. A remedial evaluation report was submitted on February 1, 2006 based on data collected between November 4 and 20, 2005. The purpose of this summative study is to provide information to allow the exhibition team, SMEC, and funders to decide if the exhibition accomplished its intended outcomes. Findings will also be useful to other institutions hosting the traveling exhibition. We used a naturalistic methodology to conduct the study using both qualitative and quantitative methods to collect data at MOS between April 1 and April 13, 2006 and at COSI between July 8 and July 22, 2006.

We worked collaboratively with the exhibit development team and the research and evaluation staff at MOS to identify questions that this study would address. The study addresses three overarching questions:

1. To what extent and in what ways did the exhibition prompt visitation by different target audiences?
2. To what extent and in what ways do visitors with a range of characteristics (including people with disabilities) engage with the exhibition?
3. To what extent and in what ways did the experience impact visitors' knowledge, attitudes, and skills?

Specific questions underlying each of these areas were identified and presented as a Topical Framework. Appendix A includes this Topical Framework.

Description of the Exhibition

As described in the National Science Foundation (NSF) grant proposal, the overarching goal of this project is to capitalize on the success, popularity, and imagination associated with *Star Wars* to attract visitors to science centers nationwide and to engage them in activities supporting the new technological literacy goals. More specific goals listed in the grant proposal include the following:

- ***To illustrate the nature of technology by engaging visitors in activities in which they employ scientific phenomena and engineering design skills to create and test technological solutions to problems.***
- ***To highlight the role of imagination and creativity in both the engineering and artistic design processes by using realistic current engineering problems and the fantastic futuristic design solutions represented in the artistry of the movies.***

- ***To engage visitors in thinking about how they might assess the potential environmental and societal implications of futuristic technologies.***
- ***To help visitors, particularly adults, become familiar with some of the topics and processes of current research and ways to follow their ongoing development.***
- ***To help visitors, particularly children, see that they play a role as future scientists, engineers, workers, consumers and citizens, in creating the technologies of the future.***
- ***To help teachers and parents become familiar with new technological literacy standards and resources available to support their implementation. (Museum of Science, 2003)***

The target audience of this exhibition was "a broad range of children and adults, not just those already technically oriented" (Museum of Science, 2002, p.1) or those with a deep interest in the *Star Wars* movies. In addition, MOS has a long-standing commitment to making museum experiences accessible to people with disabilities.

The exhibition design team had a clear rationale and strategy to accomplish these goals. The rationale for the project involved using technology challenges anchored in well-known *Star Wars* movies to encourage "…visitors to explore scientific phenomena of the real-life 21st century that could lead to a real-life technology." (Museum of Science, 2005 p. 3)

The exhibition reflects two technology themes, "getting around" (transportation) and "getting along with more and more intelligent machines" (robotics). These themes were chosen based on an appeal to a broad audience, their representation in all six *Star Wars* films, the availability of real-world technology analogues, and a good fit to the goals of the project. (Museum of Science, 2005, p. 5)

Developers used similar organization and design components in each theme area:

> ***The theme areas will be organized in the same fashion. They begin with a Star Wars vignette of a large movie prop and objects, costumes, etc. belonging to the character or characters we are using to host the area.***
>
> ***The way that particular technology manifests itself in the Star Wars universe will be explored using actual props, models, and audiovisual components covering all six Star Wars films. Video interviews with the creators of the movies will highlight their motivations and the creative process that brought the stories to life.***
>
> ***We will then highlight technologies that answer the same need in the real world. Using artifacts, models, and video of these technologies at work in the world, we will explore the decisions that shaped the development of these technologies. Interviews with the creators will explore their life stories, passions, and inspirations.***
>
> ***The central focus of each area will be a series of interactives that explore the scientific phenomena necessary to understanding the technologies being showcased. The culminating activity will be a large, multi-station engineering design-build activity where visitors will be able to synthesize the knowledge and skills and put them to work.***

In addition, each area will have freestanding exhibits that focus on specific worlds in the Star Wars galaxy. These will feature costumes, models, and props and be heavily Star Wars themed and all address environmental issues that might be associated with that specific planet. (Museum of Science, 2005, p.4)

Two large multi-station exhibits or engineering design labs (*EDL*s) are anchored in each theme area. The goals and underlying rationale for these experiences are explained in the content outline:

As the culminating activity of both theme areas, the Engineering Design Labs need to explicate the main challenge laid out for each section, and allow visitors to feel that they have been able to address that challenge meaningfully. Those challenges are:

1. ***Getting Around***
   How would you design a vehicle like Luke's speeder?
2. ***Robots and People***
   How would you design a robot like R2-D2?

To achieve this goal, we are developing two large multi-station interactive exhibits where visitors engage in a three-step, cyclical design activity where they complete the following steps:

1. ***Create a design by physically piecing together and creating an object from materials that lend themselves towards creating more than one design.***
2. ***Test that design and assess its success relative to a given goal (which can be a visitor, or, exhibit-generated goal)***
3. ***Refine or redesign the original creation, by developing a new design that better achieves the visitor's original goal, or works towards a new goal that the visitor came up with based on the results of the testing.***
   (Museum of Science, 2005, p. 20)

These two *EDL* areas were intended as important culminating experiences for visitors. They are also important in the field of exhibition design such as MOS's *Investigate!* Project, the *Experiment Workbenches* at the Science Museum of Minnesota and the *Active Prolonged Engagement (APE)* project at the Exploratorium. These exhibits shift visitor focus from the outcomes of the experiences to the experiences themselves (Ansbacher, 1998, 1999). Since the 1970s, science museums have become expert in providing hands-on access to phenomena that can, through strong initial engagement created by carefully crafted labels, produce simple understandings of scientific phenomena. But providing opportunities for deeper engagement with the phenomena, thereby enabling visitors to guide and construct their own knowledge, has been more difficult. These exhibits have the potential to provide visitors with an experience base that connects with the work of engineers and technology in the real world. Exhibit developers in each of these projects have recognized how difficult it is to design these experiences and how effective they can be when all the elements work together.

Universal design strategies were used to make the *Star Wars* exhibition welcoming for people of all abilities and disabilities. Universal design features included multi-sensory interactives,

multiple modes of communication, and architectural design making experience accessible for children, tall adults, and people in wheelchairs. In addition, each station had an audio description which could be accessed by a one-inch square button on the left-hand side of the station. Computers had tactile controls placed within an easy reach of the table. Open captions were provided on all video stations and high contrast large font text labels were provided. At both MOS and COSI a multimedia tour (MMT) was provided with PDAs. Visitors who were deaf could use a version that provided information in American Sign Language (ASL). Visitors who were blind or with limited dexterity could use an audio-only version of the multimedia tour (Museum of Science, 2005). These MMTs were provided free to people with disabilities.

Comparing the Exhibition Experience at Two Venues

In order to have more robust summative findings, we looked at the exhibition experience of visitors at two sites, MOS in Boston, where the exhibition was developed, and at COSI in Columbus, Ohio. In general, the same exhibits and spatial thematic organization were available for visitors at both sites. Temporary exhibition galleries were similar in size. These sites provided quite comparable experiences. There were a few important differences that should be kept in mind in interpreting findings. Actually, these contrasts allowed some comparisons that will inform decisions at future venues. These are summarized here and described in detail in the findings section. This allows the specific change to be considered in relation to findings.

There were several differences, some minor and some more important. The temporary exhibition spaces themselves had some different characteristics. Some exhibit elements were placed differently in relation to other exhibits. In addition, the exhibition team had completed some remedial changes after the April data collection period at MOS and before the exhibition traveled to COSI. These included revisions at both *EDLs* and changes in the number systems for HearPhones and MMTs. Another variation was changes to an exhibit that allow visitors to ride a hovercraft. The state of Ohio ruled that *1.08A Ride on a Cushion of Air* (chair) was an amusement park ride. COSI made changes to meet these requirements. Finally, we studied the exhibition at different times of the year. All these factors will be considered in the findings about visitor response to the exhibition at the two sites.

At MOS, shortly before the exhibition opened, the team decided to move the *Millennium Falcon* to the first floor as a separate ticketed experience. The purpose of moving the exhibit was twofold: to allow more room in the gallery for traffic flow and to avoid the long lines that would develop from a timed-exhibit accommodating only a few visitors at once. It was also hoped the exhibit might serve as an attractor for the exhibition. At COSI, this exhibit element was placed inside the gallery and included in the ticketed price. At MOS the gift shop was outside the exhibition space. Once visitors left the exhibition they could not re-enter. At COSI the gift shop was included in the exhibition space.

METHODOLOGY AND METHODS

Methodology

Naturalistic Inquiry

We used naturalistic methodology (Lincoln and Guba, 1985; Wolf & Tymitz, 1977) to collect and analyze data. Naturalistic inquiry aims to provide a holistic understanding of a phenomenon by looking at it from several angles in a real-life setting. This type of inquiry uses a systematic approach for collecting and analyzing data in the context in which it occurs. In naturalistic inquiry, processes and activities are captured through a variety of sources from multiple perspectives of various stakeholder groups and presented through deep descriptions. The impacts of the program are also captured through this process and connected to these processes and perspectives of the people involved. Literature analects are another source of data, allowing the program team to connect their own experiences and those of the participants to a larger community of practice.

In naturalistic inquiry, data collection and analysis are iterative processes. For this study, we analyzed data using a modified inductive constant comparison approach (Lincoln & Guba, 1985), whereby each set of data was compared with previous data sets to direct the focus of subsequent data collection. Data collection and analysis methods are described in more detail below.

Methods

Although often focusing on qualitative methods, naturalistic inquiry is primarily concerned with understanding the phenomena under investigation as completely as possible. In this study, this required the use of both qualitative (i.e., observations and semi-structured interviews) and quantitative (i.e., tracking & timing and structured interviews) data collection methods. Data collection involved several methods to answer questions in the Topical Framework. We have included the number of data sets and respondents by method in Table 1.

Table 1. Data Sources by Method

Method	Site	Data sets	Unit of analysis	Unique respondents	Data collectors	Dates
Tracking & timing	MOS	70	Individual	70	3	April 1, 2006
	COSI	55	Individual	55	5	July 8, 2006
Structured exit survey	MOS	44	Individual	0	3	April 1,2006
	COSI	33	Individual	8	5	July 8, 2006
In-depth interviews (DI)	MOS	16	Group	48	3	April 1-3, 2006
	COSI	17	Group	60	3	July 8-10, 2006

Method	Site	Data sets	Unit of analysis	Unique respondents	Data collectors	Dates
Focused observation & in-depth interview (FO)	MOS	5	Group	15	2	April 1-2, 2006
Accessibility observation & in-depth interviews (ACC)	MOS	5	Focus individuals (5)	10	2	November 4-6 and November 20, 2005
	COSI	4	Focus individuals (7)	10	2	July 8-10, 2006
Focused observations (FOC)	MOS	1	Exhibit area		1	April 3, 2006
	COSI	1	Exhibit area		2	July 10, 2006
TOTAL VISITOR RESPONDENTS	MOS	172		143		
	COSI	119		125		
	ALL	291		268		
Focused interviews (FI)	MOS	3	Individual	8	1	April 3, 2006
	COSI	3	Individual	3	1	July 9-11, 2006
TOTAL STAFF RESPONDENTS		6		11		
TOTAL		**297**		**279**		

Data Collection and First Level of Analysis

In this section, we describe each of the data collection methods including the method of selecting respondents. We also describe the first level of data analysis. In general, for qualitative methods the first level of analysis involved writing debriefs of specific observations and interviews. We also conducted three group debriefings at each site. Five of these discussions were transcribed to aid in subsequent analysis. For quantitative methods, we used the Statistical Package for the Social Sciences (SPSS) to calculate descriptive and inferential statistics. These first levels of analysis provided the basis for the final analysis, where multiple methods and multiple perspectives were used to draw conclusions.

Tracking & Timing

A total of 125 respondents over age 18 were observed by eight data collectors as part of tracking & timing data collection. Three data collectors at MOS tracked and timed 70 respondents. Five data collectors at COSI tracked and timed 55 respondents. To make this sample as representative as possible, we scheduled data collection on both weekdays and weekends and during all hours of exhibit operation. Data collectors avoided selection bias by picking a spot on the floor and

selecting the third visitor over age 18 to walk across that point. The time a respondent entered and exited *Star Wars* was recorded. Data collectors observed and noted several demographic variables including age category, group type, the number of children in a group, and whether the respondent used an MMT. We did not include gender on the tracking form at MOS, and this information is available only for respondents who agreed to be interviewed for the structured exit survey. A reduced-size copy of the front tracking & timing instrument used at COSI is included in Appendix B. We placed demographic items on the back of this map. Using the map, data collectors recorded the amount of time in seconds that respondents spent at each exhibit. Data collectors calculated and recorded total time spent in the exhibition as the respondents exited the gallery.

We analyzed the time data to calculate two indicators developed by Serrell (1998) from her analysis of tracking & timing data from 110 museum exhibitions. Then we made comparisons for groups of respondents. This analysis is helpful for making judgments about the overall usability of the exhibition by a broad range of visitors. We also analyzed data by specific exhibits to help exhibit designers identify relatively stronger and weaker performance among the exhibits in the exhibition as a whole. For both exhibition-wide and exhibit level group comparisons, we calculated inferential statistics using SPSS, using non-parametric tests where appropriate. All reported significant differences are at least $p < .05$.

Structured Exit Survey

We designed a structured exit survey with several identical items for use at both MOS and COSI. We made adjustments on three items and in script language for COSI data collection. Appendix C includes a copy of the structured exit survey used at COSI. At both locations, data collectors intercepted respondents who had been observed via tracking and timing as they exited the exhibition and requested a 5-minute interview about their experience. At MOS, 55 of the 70 respondents tracked agreed to be interviewed for a response rate of 62.9%. AT COSI, 25 of the 55 individuals tracked agreed to be interviewed for a response rate of 45.5%. Due to the long periods of time people visited the exhibition, we selected additional respondents in a nonbiased manner as they exited the exhibition to provide eight additional exit surveys. This provided us with a total of 33 structured exit surveys at COSI, a sample large enough for group comparisons between sites.

For exit survey data, we also calculated frequencies and ran group comparisons. For several rating items, we created variables to help simplify comparisons. To compare groups, we used similar inferential statistical tests as those used on tracking & timing data. We also calculated correlations between items and performed some cross tabulations between groups.

In-Depth Exit Interviews

Respondent groups were purposefully selected by evaluators from Tisdal Consulting and asked to participate in a 20- to 25-minute in-depth interview. We purposively selected groups so that we would interview visitors with a broad range of characteristics. Our initial selection criterion was group type. We also screened groups to find people who had spent a wide range of times in the exhibition. At MOS, three individuals conducted interviews: Carey Tisdal, Caren Oberg, and Valerie Carroll. At COSI, three individuals conducted interviews: Carey Tisdal, Caren Oberg, and Joan Esserman. We conducted 16 in-depth interviews with groups at MOS and 17 at COSI.

As part of these interviews, we collected 17 pictures drawn by children at MOS and 19 pictures drawn by children at COSI. By identifying the topics in the drawn picture along with the child's description of the drawing in the interview, themes and patterns were identified across interviews and across drawings. We considered the context of the visiting group, both adults and other children, in the topics of the drawings. Appendix D contains a copy of the in-depth interview protocol.

Focused Observations & In-Depth Interviews

In order to assess the effectiveness of several remedial changes to *1.09 Maglev EDL* area, we conducted five focused observations and in-depth interviews with respondent groups. We used purposive selection to identify respondents. We used group type and length-of-stay to find a range of experience in this exhibit area. Interviews lasted between five and 10 minutes. Caren Oberg and Carey Tisdal conducted these interviews. We wrote debriefs immediately after each observation and interview, and some were recorded as part of group debriefs. Appendix E includes this protocol.

Focused Observations

In order to answer specific questions that we identified as part of the debriefing process, we conducted three focused observations. At MOS, we counted the number of visitors at each station of *1.09 Maglev EDL* at five-minute intervals for 30 minutes. We did this to collect further information about whether (a) only groups with children under 18 were using the exhibit areas and (b) if groups were using multiple stations. We conducted a similar observation at COSI. In addition, we identified several questions at COSI about the relative lack of dissatisfaction we had heard despite a long wait for *Millennium Falcon.* We interviewed and observed groups waiting in line. With permission, we recorded a staff member providing information to visitors waiting in line for this experience. This recording was transcribed. Other audio recordings were not transcribed, but quotes are used in this analysis.

Focused Interviews

We also explored specific questions by interviewing staff members at both MOS and COSI who were managing timed ticket lines to enter the exhibition and lines at timed experiences within the exhibitions. We also interviewed security guards and exhibit technicians to gather their perspectives on visitor behavior in the exhibition generally. We interviewed exhibit technicians at both locations about their assessment of the types and level of repair necessary to keep the exhibits functioning. We recorded and transcribed six of these interviews with a total of 11 staff respondents.

Accessibility Observations & In-Depth Interviews

A total of nine accessibility observations and in-depth interviews are included in this report. As we began data collection for this study, we learned that some of the remedial changes to increase accessibility would not be completed by the time we began data collection at MOS. Time allotted for these observations and interviews was used to look at the *Maglev EDL* changes. The five accessibility observations and in-depth interviews conducted for the remedial evaluation during November 2005 are included in this report. At COSI, we collected an additional four observations and in-depth interview data sets. Carey Tisdal and Joan Esserman collected this data at both locations.

Respondents were selected on the basis of purposive sampling to answer questions about the accessibility of the exhibition for visitors with a range of disabilities. MOS recruited respondents from communities of individuals with disabilities who share MOS's goals of making the museum experience accessible and welcoming for these visitors. At COSI, they were recruited from personal networks and a local nonprofit advocacy group for people with disabilities.

We observed these respondents engaging with the exhibition as they simultaneously commented on their experiences. Several respondents were accompanied by family and friends, and the data collector joined the visiting group in using exhibits and discussing them. These observation/in-depth interview data collection sessions lasted from 2.25 to about 3 hours. The initial protocol for observation and depth interviews is included in Appendix D. This protocol was adapted to specific situations.

Final Data Analysis

The final stage of analysis was completed when all data had been collected. Both qualitative and quantitative data relevant to each question in the study were compared to identify findings. Data were triangulated from multiple perspectives, sources, and documents to draw conclusions.

Characteristics of Respondents

The purpose of this section is to describe the number and characteristics of respondents associated with each method. The tracking & and timing and the structured exhibit survey sample were selected in a way so that numbers could be generalized to the population of visitors to the exhibition. These methods are the source of the Audience Profile in the Discussion of Findings. Numbers associated with in-depth exit interviews and other qualitative methods should not be generalized to the population of visitors.

Tracking & Timing

The tracking & timing sample of respondents (N = 125) were selected in a non-biased manner. The samples were quite similar at MOS and COSI, indicating that the exhibition tends to attract a specific visitor profile. This set of respondents was the source of information presented as an audience profile in the findings section. Detailed demographics are included in Appendix F.

Structured Exit Survey

All respondents to the structured exit survey were over 18 years of age. We drew most of these respondents from the tracking and timing sample, so the characteristics of these groups are fairly similar. We also used this source for the visitor profile. The only significant difference was in the percentage of respondents in groups with under children 18 years old. This was lower in the survey sample that the tracking & timing sample at both locations. This means that the structured exit sample will yield findings somewhat less representative for people visiting in groups with children. Respondents in groups with children were probably less likely to agree to stop and be surveyed than those in adult groups. Respondents from this source also contributed to the Audience Profile in the next section. Detailed information on these respondents is provided in Appendix F.

In-Depth Exit Interviews

We conducted 33 in-depth exit interviews with a total of 108 respondents. We conducted 16 in-depth exit interviews at MOS and 17 at COSI. We selected these respondents purposively to understand engagement in the exhibition among a wide range of social groups. Among these

groups, the length-of-stay ranged from 15 minutes to a five-person group that stayed 170 minutes. Group size ranged from 1 to 15. Table F.1 in Appendix F provides detailed demographics for these respondents.

1.09 Maglev Focused-Observations & In-Depth Interviews

At MOS we conducted five focus-observations followed by in-depth interviews to answer several questions about changes to *1.09 Maglev EDL*. We selected respondents to get a full range of group type and engagement time. Engagement lasted from 3 minutes to 36 minutes. Table F.2 shows the detailed demographics for the respondents.

1.09 Maglev Focused Observation and Brief Interviews

Also at MOS, we conducted a focused observation follow by brief interviews to learn more about the effects of crowding at *1.09 Maglev EDL*. We counted the total number of people in the area at timed intervals using the exhibit. We interviewed a total of 16 social groups with about 35 individuals who chose not to use the exhibit area. Social groups interviewed included 5 groups of adults alone, 3 groups with children under 6 years old, 3 groups with children 6 to 12 years old, 1 group with a child over 12, and 1 group of teens.

Accessibility Interviews—Demographics

MOS and COSI recruited these respondents from among their contacts in the community-based organizations to allow us to explore the accessibility of the exhibition for people with a wide range of disabilities. We conducted most interviews (7 of 9) in the context of a social group. One professional caregiver and 3 ASL interpreters were also part of groups with which we visited the exhibition. These nine datasets include 12 focus respondents with disabilities and other people with whom they visited the exhibition. This helped us understand the impact of accessibility issues on the social aspects of the visit. We visited the exhibition with 2 respondents who were deaf, 3 with blindness and/or low vision; 4 in wheel chairs with physical mobility disabilities, and 2 with learning disabilities. Six of our interviews were with social groups that included only adults over 18 years old, 2 respondents were alone, and 1 was with a child under 18 years old. Table F.3 provides detailed demographics for these respondents.

Limitations

The primary evaluator began this study firmly convinced that the best summative picture of the effectiveness of an exhibition would include both quantitative and qualitative findings integrated into a coherent whole for the exhibition team, other staff members of institutions, future venues of the exhibition, and people interested in informal science education and theory. This ideal study would be readable, interesting, and accessible to this wide range of audiences, and provide supportable triangulated conclusions for all findings. It would present information to allow the reader to understand audience characteristics that influence engagement and outcomes. It would allow the reader to have a clear picture of how visitor engagement influences outcomes. Outcomes would be fully and clearly assessed. This study is not that ideal study.

We found it challenging to smoothly integrate the findings between qualitative and quantitative methods into a coherent whole. Findings about audiences and engagement appear fairly clear. But some elements of the outcomes and impacts are not as fully supported and clear as they would be in that ideal study. Transitions may be difficult for some readers between the style used in the presentation of qualitative information and the more storytelling style often used in

qualitative studies. The connections between the findings in this study and the informal science learning field of study and practice may be too large a leap for others. Zooming and panning among different perspectives can optimally provide a deeper and more comprehensive picture of the whole. At times such different perspectives may simply make the reader dizzy. We aimed for more of the former than the latter. It was not always achieved.

There are several important findings in this study which we identified, but did not explore as fully as we would have liked. The first and most important is impact. We planned and carried out an online survey to follow-up with visitors to learn more about the level of impact some time after the experience. Of the 72 email requests to participate only 14 responded. This was a response rate of 19.4%. Interestingly enough, 13 or the 14 responses were from MOS a year after their experiences. Only one response was from COSI. Responses were consistent with impact findings on real world technologies—people provided examples of following up on these interests. The low response rate was not a weakness of the method. If properly used with reminders, response rate would have been higher. It was a weakness in competing priorities in a study whose scope was already large.

There are also several issues we identified, but were not able to explore fully. Some of the topics may be appropriate for research studies. First, we identified some parents, particularly among new and infrequent visitors, who wanted to guide their children's learning but did not have the confidence in their own science and technology competencies. These respondents also had the fewest "museum going" skills. That is, choosing to come on a less crowded day, resisting pressure to move on before an engagement is completed. What types of supports and guides would be helpful to these parents?

Finally, focused observations of the two EDL's at COSI would have provided a better understanding how these exhibitions worked after remediation and under the crowded conditions. Adding this element with the two additional foci that require specialized method (e.g. accessibility and learning in children) was not practical given the resources. Information is provided about the overall level of use, number of stops, and order or use.

In summary, we made decision about priorities in collecting, analyzing data, and reporting information. In a summative study, the whole takes priority over the parts. That was the guide we used to make these decisions.

DISCUSSION OF FINDINGS

We discuss findings in four major sections: Audience of the Exhibition, Engagement with the Exhibition, Outcomes of the Experience, and Accessibility. These findings focus ways and extent to which the exhibition attracted the intended audience, provided engagement that supported the intended goals, and impacted the knowledge, understanding, and skills of visitors. The purpose of this discussion is to provide the exhibit team and other staff at MOS with useful information focused on the effectiveness of their strategies. These findings are also intended for the funding agency to assess the extent to which the project goals have been accomplished. Some finding will be relevant to other institutions to which this exhibit travels and to exhibit designers' interest in the strategies and approaches used in the experience.

First we will discuss characteristics of the audience of the exhibition at its first two venues. Looking at the audience across two sites provides insight into the consistent ability of the exhibition to attract visitors. Understanding the characteristics of these visitors provides context for understanding how they used the exhibition and what learning goals they accomplished. We also consider the effectiveness of the *Star Wars* exhibition in attracting new and infrequent audiences to institutions.

In Engagement with the Exhibition, we describe how visitors used the exhibition from a variety of perspectives. This section will provide a framework through which to understand how the various elements of the exhibition influenced how visitors understand the messages and accomplish the learning goals of the exhibition. First we will look at how thoroughly the exhibition was used by using two performance indicators developed by Beverly Serrell (1998). These indicators will give us a broad view of how thoroughly used this exhibition was compared to other exhibitions. We will also look at the relative levels of exhibition use by different groups of visitors. Next we will look at the exhibition experience through two more focused perspectives: (1) an analysis of the pathways visitors used to move through the exhibit and (2) the attraction and holding quality of various exhibit elements. These analyses will allow us to assess the relative effectiveness of several of the exhibition strategies designed to accomplish the learning goals. Finally, we will take a closer look at several aspects of the exhibition that played important roles in visitor experience. These include a closer look at staff interaction with visitors, the two *EDLs*, and the two timed presentations, *2.02 Robot Theater* and the *Millennium Falcon*. We concluded this section with five vignettes from in-depth interview respondents. These provide a view of the range of engagement we learned about from that data source. They provide a deeper view of the interrelationships among engagement, social role, meaning orientation to the *Star Wars* films, and outcomes and impacts,

In the third section, Outcomes and Impacts, we will discuss to what extent and what ways visitors understood the messages and accomplished the learning goals set forth for the exhibition. In this section we will assess the overall levels of satisfaction with the exhibition, the extent to which visitors understood the Big Idea, and the extent to which visitor accomplished the learning goals. In this section we will integrate both quantities and qualitative data.

In the fourth section, we present findings from nine accessibility interviews. We focus on the design elements included in the exhibitions, and the overall level of accessibility by people with different disabilities.

Audience of the Exhibition

The underlying rationale of using the *Star Wars* theme included attracting a wide range of visitors, not just those interested in science and technology, and not just fans of the movies. In addition, this exhibition was designed to attract new and infrequent visitors to the museums where it travels. In this section we present findings related to the characteristics of the audience and the overall effectiveness of the exhibition in prompting visits among new and first-time visitors to the institutions. Popular, highly visible special exhibitions play an important role in the life of science and technology museums. Special exhibitions are intended to attract new visitors to the institution and bring back visitors who have not been to the site for some time. They also play important roles in building the public persona of the institutions and contributing to the revenue streams. All the forces work together to influence the characteristics of the audience for the *Star Wars* exhibition.

Characteristics of the Audience of the Exhibition

In order to access the effectiveness of the exhibition in attracting the target audience we will consider the characteristics of the audience whom the exhibition attracted at its first two venues. In addition to describing these characteristics, we will consider the extent to which this audience included a wide range of people aimed for in the exhibition strategy. We will also consider some audience characteristics we identified that impacted the way respondents engaged with the exhibition and the outcomes of their experience.

Audience Profile

We found that the *Star Wars* exhibition, at both sites, tended to attract visitors with quite similar demographic profiles. This exhibition attracted large numbers of people visiting *with children under 18*--overall about 65.0%. The average age of children was between 7 and 8 years old, and there were only about 2 to 3 children per group. The next largest visiting social group was *adults only groups,* with about 20.0% of respondents. Most adults who visited were between 30 and 54 years old. Very few visitors attended *alone*. Most of the audience members were white and were highly educated with above-average incomes.

Knowledge and Interest

One of the aims of the exhibition was to provide a satisfying and enjoyable experience to a broad range of visitors with varying levels of interest in the *Star Wars* films, interest in science and technology, and level of knowledge about science and technology. We asked three questions on the structured exit survey that allowed visitors to identify characteristics in these three areas. These measures helped us understand who was attracted to the exhibition. They also will be useful in our discussion of how people with these different characteristics used the exhibition and to assess the effectiveness of the experience for people with different levels of these characteristics. Respondents reported their level of interest and knowledge on a 10-point scale from 1 (*low*) to 10 (*high*). Not surprisingly, ratings for all three items skewed toward the positive end of the scale based on the topic of the exhibition and the science focus of the institutions.

The overall mean rating was 7.6 (*SD* = 2.3) for interest in the *Star Wars* films, 8.0 (*SD* = 1.9) for interest in science and technology, and 6.7 (*SD* = 1.9) for knowledge about science and technology. Respondents who rated one of these areas highly tended to rate all highly.

We found a few differences in these characteristics among different groups of respondents. Females rated their knowledge of science and technology lower than did males: 6.2 (*SD* = 2.1) for females compared to 7.3 (*SD* = 1.7) for males. Other studies also show that females tend to rate their knowledge lower than men and at least some of that difference appears to be a more cooperative than competitive orientation to learning among women (Farmer, 1996; Crowley, Callahan, Tenebaum, 2001). Ratings at the two locations were quite similar. Figures 1, 2, and 3 show the distribution of ratings on these three items.

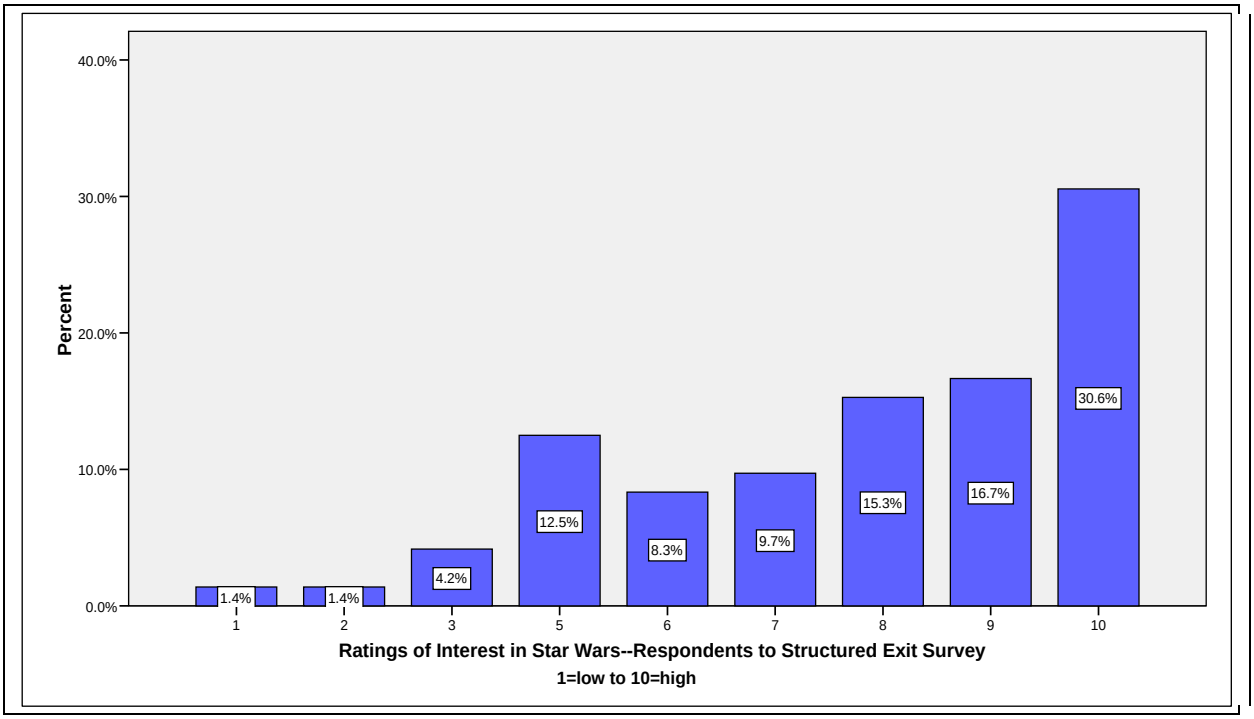

Figure 1. Ratings of Interest in* Star Wars *Films—Respondents to Structured Exit Interviews (n = 77)

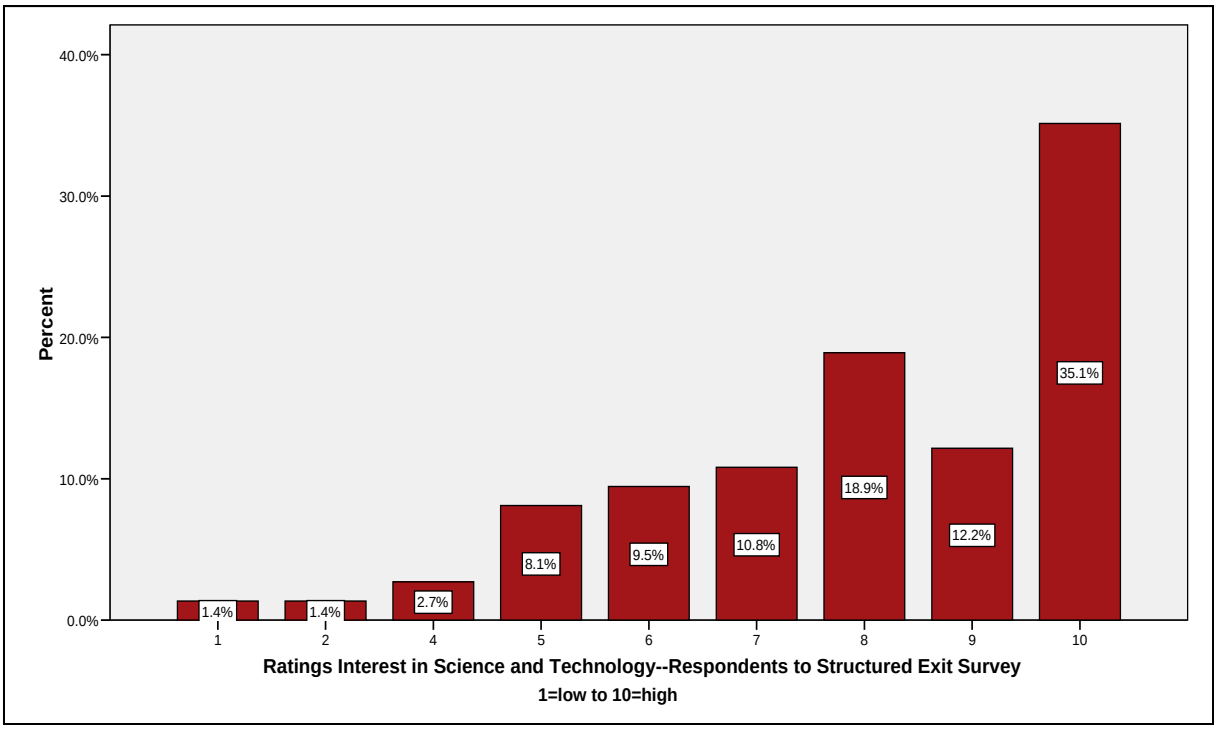

Figure 2. Ratings of Interest in Science and Technology—Respondents to Structured Exit Survey (n = 77)

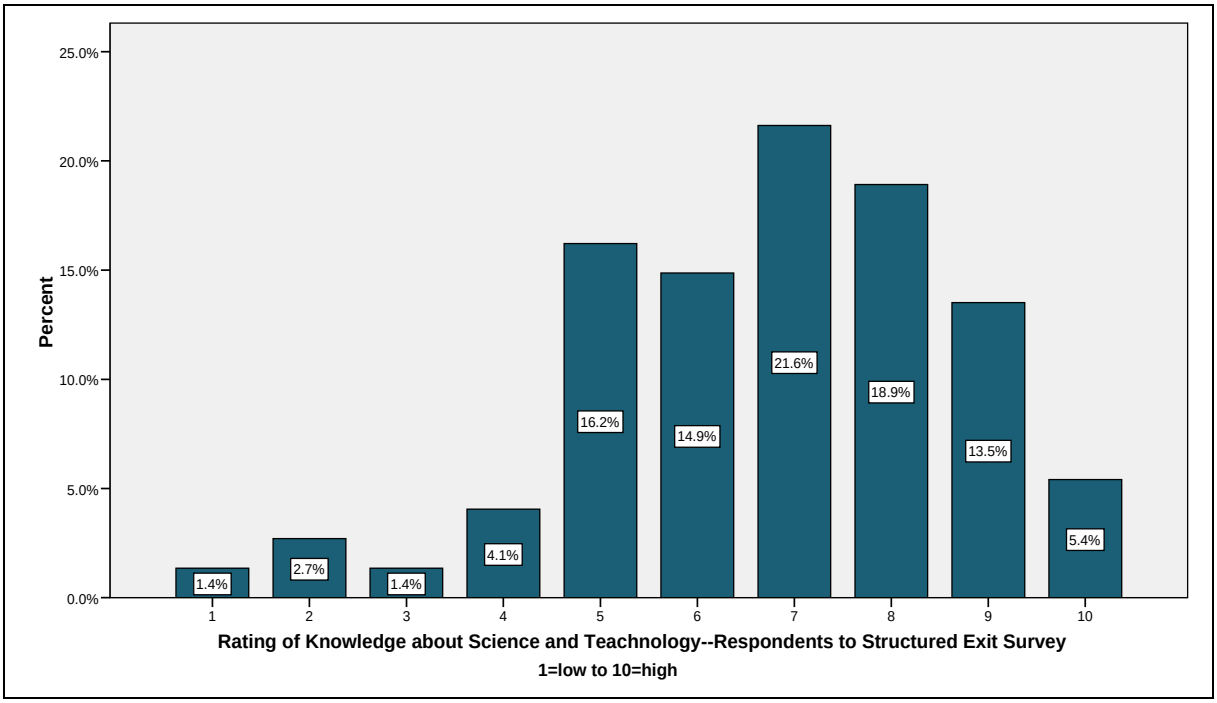

Figure 3. Rating of Knowledge about Science and Technology—Respondents to Structured Exit Survey (n = 77)

Perspectives on the Experience

In the in-depth exit interviews, we talked to respondents about their exhibit experiences. From these conversations, we found other important ways that visitors differed. We found that people came into the experience with two sets of perspectives that affected how they used the exhibition and how it impacted them. The first related to the social role the individual played in the visiting group. The second related to what aspect of the *Star Wars* films held meaning for the individual. We call this the Meaning Orientation. A third perspective related to the expectations people had about their experiences. We found different levels of engagement and outcome related to these perspectives.

Social Roles

Among members of the social groups that we interviewed, we discovered different expectations about who was expected to be the primary beneficiary viewing and actually engaging with exhibit elements. This value played out in some very specific social roles within groups. Later we will discuss how these social roles affected what respondents found satisfying about the experience.

Somebody Else's Visit--Among several visiting groups, we found respondents who did not come expecting to enjoy the experience for themselves. These individuals came, sometimes reluctantly and sometimes with great enthusiasm, for the benefit of other people. Among adult respondents, several had purchased *Star Wars* tickets for a boyfriend, girlfriend, husband, or wife as a birthday present. In other cases, fathers had been convinced to bring a group of teenagers to the exhibition. Some children, particularly in larger groups with several siblings, would place themselves into this group. These visits had been planned as family outings based on one child's high interest. Overall, these respondents made up only a small part of the overall audience. They did affect others' experiences in their social groups. As one woman explained, when we asked her about the visit:

> ***Just ask him, because I'm not really interested in it. . . . I like the costumes. I don't know. I just thought it was cool to see memorabilia from the show--I mean from the movies. . . . I'm not a Star Wars fan. It's [my husband's] birthday, so I got it for him and came here. (STW2B_DI_040206_CO_3_tr, p. 2, female)***

Group Manager--*Group Manager*s were at the next level of expected personal benefit. For respondents in this group, the primary focus was managing children, shepherding members of large groups, and making sure other people had a good time. With an average of nearly three children in a group, we found a wide range of ages among children in one visiting group. Frequently mothers played this role, although fathers and grandparents sometimes did, too. Fathers appeared more likely to play this role when they accompanied children to the exhibition without another adult. These individuals were centrally focused on other people having a positive experience. In the exhibition, *Group Manager*s would be the individual who would wait in line for others. They might also sit on a bench with a baby or younger child while others in the group used an exhibit area. We found adults more likely to take this role when the group included a baby or very young child. The *Group Manager* would sit or stand outside an exhibit area with the younger child while another adult assumed the role of a *Learning Guide*.

At COSI, one couple explained the woman's role in the visiting group.

> ***Female: Well, it always happens, the women wait and the men and the kids go and do stuff.***
> ***Male: They--they volunteered--they volunteered to wait.***
> ***(STW2C_DI_070806_CO_2_tr, p. 6)***

Learning Guide--Frequently a father played the role of *Learning Guide*, but mothers with no babies or toddlers in the group also guided and directed children's experience. This individual used the exhibits with children or with other group members but as a facilitator, guide, or director. At the *EDLs* this group member would supervise others' interactions and sometimes participate by assisting in the design, but would rarely build his or her own car or robot.

We found several father-child groups where the father took this role category. This father with two sons explained why he had come to the exhibition.

> ***I kind of came along for the ride. I promised him I'd go with him to the exhibit. And he kind of got me into* Star Wars*. He's a--he's a big fan. And he has all these toys lying around the house. And it started to, you know, get into all the characters. So I said, I'll bring you one day. And we just never got the time to go. So we said, let's take a day off. We're going to go before it ends. (STW2B_DI_06040_CO_4_tr, p. 6, male)***

Primary Visitor--At the highest level were *Primary Visitor*s. These respondents were focused on their own enjoyment and learning in the exhibition. Almost all the children fell into this group. With teenage children, parents sometimes were in the group. In adult groups, two or more adults might take socially equal roles in engaging with exhibits together in an equal learning partnership. This does not mean that individuals in the group did not share and influence each other's experience, but they had a socially equal role within the group.

Among larger groups of adults, almost all individuals considered themselves *Primary Visitor*s. We interviewed four young men (ages 18 to 22) from Sidney, Ohio. One was a friend home on leave from the military, and two of them worked together. They, too, communicated that coming to the exhibition was a special occasion. They said they drove about an hour and a half to see the exhibit.

> ***Male (age 19): I heard about it on the radio when we were--when I was at work, we had the radio playing in the back. And I heard that was happening. And I was like, oh that would be cool to go see that. It was his decision actually.***
> ***Male (age 22): Yeah. My decision. . . . I didn't know he knew about it and I told him, thinking he might not have heard. But he already knew and he was like, hey let's go, too. . . . I was the one who drove today, organized the time--got all the info.***
> ***(STW2C_DI_071006_CT_5_tr, p 3-4)***

What Star Wars Means to Me
As we interviewed people, it quickly became apparent that everyone who said they were *Star Wars* fans did not mean the same thing. Some respondents focused almost entirely on the

narrative elements of the film--the plot, characters, and epic battle between good and evil. Others appeared to focus on the action/adventure elements. For those with the action/adventure orientation, technology was already a prominent part of their idea about *Star Wars.* Respondents focused on the narrative elements appeared much more intense in their fandom. Some action/adventure fans were more enthusiastic than others, but they were not nearly as intense as those focused on the characters. We found that we could categorize all the respondents in our in-depth interview based on what in the *Star Wars* films they found meaningful and their level of intensity. These groups are related to level of interest, but they tell us more about how people entered the exhibition, how they engaged, and how they were impacted.

Star Wars Indifferent--We found a few respondents for whom the *Star Wars* films held little meaning. They did not appear to find meaning in the narrative elements (i.e., plot, characters, and themes) or enjoy the action/adventure and technology elements. Generally, members of this group were likely to be attending with someone with a greater level of interest and intensity about the *Star Wars* films. We found only a few of these respondents. They were generally visiting with someone who did find something meaningful about the films. One 20-year-old woman, part of a dating couple, when asked what she liked in the exhibition replied:

> ***Did I like anything? What did I like? I like him. (STW2C_DI_070906_CO_4_tr, p. 2, female)***

***Star Wars Explorer*s**--These individuals displayed a mild interest in the *Star Wars* films. Some respondents came to the museum to see another venue. The *Star Wars* exhibition was an addition to their visit. Several museum members fell into this group. To them the exhibition was another attraction offered by the museum, but was not a special event. While these individuals might initially identify the narrative elements or the action/adventure elements, they were not particularly intense about either. People with both high and low levels of knowledge about science and technology fit into this category. Yet some adults in this respondent group appeared to have the highest level of interest in learning about science and technology. Among this group, we found many respondents who lived fairly close to the site of the exhibition. Some were members. Not much money or travel time had been expended to come to the exhibition. We encountered several of these visitors to the exhibition.

One of our *Star Wars Explorer* respondents was father of 5 ½ year old twins. This threesome had come primarily to see *Big Machines*, another special exhibition at COSI.

> ***How did we decide to come see it, oh today? We were just coming today because we--we knew--we were actually going to come on the 13th because they have a member thing this Thursday. But we came down today to see the construction exhibit. And then we checked on the prices and figured out we may as well go today because it's not going to change on Thursday, so we just came today. (STW2C_DI_070906_CT_4A_tr, p. 3, male)***

At MOS, we interviewed a local mother and daughter, age 11, who came primarily to see the IMAX film and decided to see *Star Wars* while they were at the museum.

Well, we've been seeing it--you know ads for it and everything. And we just decided to come in and we're coming to see the--we wanted to see the movie about Greece. STW2B_DI_040206_CO_2_tr, p. 1, female, age 11)

We talked with a college-age couple from Montpelier, VT, and Williamsport, OH. Both liked *Star Wars* but did not describe themselves as big *Star Wars* fans. He was majoring in electrical engineering at Ohio University and she was a dance major interested in space.

Female (age 18): Well my mom works at the Ohio department of Ed. which is like right by here. . . . So I don't know. We were just talking about it the other day and decided to. And we were talking about it, too.
Male (age 18): I had a free pass as well. . . . It was from helping out with Big Brothers/Big Sisters or something--something like that.
Female (age 18): I just--I was interested because it--I heard about, you know, how it's new and stuff. So I thought it would be really exciting to come.
(STW2C_DI_070806_CT_3_tr, p. 2)

Star Wars Adventurers--These respondents displayed a high level of enthusiasm for *Star Wars* films. They enjoyed both the narrative aspects of the films (e.g., plots, characters, themes of good versus evil) but the action/adventure theme and fantastical technology drew their intense interest. Both males and females respondents had this perspective, but as a group, males predominated. Adults seemed somewhat more likely to display this perspective than children, but teenagers and college students were equally as likely as adults to be *Star Wars Adventurers*. We found both locals and tourists in this category. This father clearly showed this perspective.

Because, oddly enough, I think in a real sense that--what makes the movies kind of enjoyable, was kind of thinking, oh, you know this kind of stuff really sort of exists. You know, and they've kind of taken a look at that. So I think the stuff with the hovercraft and the Maglev trains really sort of nailed that. You know it seems kind of fanciful to watch it on the big screen. But, you know, there are folks that have taken a real serious look at it and seen you can have a positive impact on--on how we're living our lives. (STW2B_DI_040106_CO_1 tr, p. 5, male)

Star Wars Epic Fans--These respondents displayed the highest level of intensity toward the *Star Wars* films. They were very focused on the narrative elements (i.e., the battle between good and evil in the films, the characters, and the plots). They wanted to see very specific characters, especially Yoda, Darth Vader, and Darth Maul. They focused on props, costumes and artifacts from the films. Most of these individuals identify themselves as someone highly interested or knowledgeable about science. These individuals often had very high expectations for a thrilling special event. We found a few adult males, but most of the *Star Wars Epic Fans* we talked with were adult females. Many children also were in this category. While we found this perspective among both locals and tourists, many of these respondents were tourists.

At COSI, we talked with a group led by a 7th-grade girl. She had instigated the trip. Her father drove a group of four young people (boys ages 15 and 11 and girls ages 11 and 12) about 90

miles to see the exhibition. The father gave no indication of any interest in the *Star Wars* films and had not been to COSI since he was a child. The daughter of the driver said:

> ***I wanted to go back--I wanted to come and I asked my dad if we could, and we did. And I brought two friends, them two. . . . I wanted to see this Star Wars convention thing because my teacher told me about it. She's like a* Star Wars *geek. (STW2C_DI_071006_je_1_tr, p.3, female, age 12)***

One mother explained her shared interest in the films with her daughter.

> ***We're fans of the film--of the--of the series. . . I'm an even bigger fan. I came up with, you know, the lines of the--of Episode I by heart. But it's--it's just a fun event. I mean we just love the scene, you know, we love the characters. We like the message behind Star Wars, so it's more like a personal, you know, joy. . . . it's good versus evil. I mean, you know, how good prevails. You know, that yes in life you go through the struggles and you have to go through a journey, but at the end you--you know you come--you come out on top. (STW2B_DI_040106_CO_1_tr, p. 2, female)***

At MOS, we interviewed a couple in their forties who had been dating for several years.

> ***Male: Oh, it was in the paper, you know, a big advertisement for it in the paper. And then it was a birthday gift for her.***
> ***Female: It was my birthday, three months ago. But we just hadn't celebrated yet. I'm the more into it --***
> ***Male: Yeah. More obsessed, yeah. . . . .***
> ***Female: Yeah. We didn't touch the hands-on stuff. We just looked at all the movie stuff. (STW2B_DI_040306_CT_10_tr, p. 3)***

Intensity of Excitement and Travel

As we discussed in the previous section, some levels of intensity were related to traveling to see the exhibition. While many local respondents were excited too, the tone of the interviews from out-of-town visitors indicated that this was one factor that provided a high level of intensity to a visit. Travel made coming to see the *Star Wars* exhibition a big event for many of the respondents. Some groups had traveled several hours, some staying in hotels. Adults reported taking a day off work to attend, and children reported missing school to come. As the mother in one group explained:

> ***[I found out about the exhibition] through AAA, actually. AAA magazine. . . .It mentioned that it was--that it was going to be here. So I looked it up and decided to come up. . . . Well, I wrote a letter to [my daughter's] teacher that we needed to get away. . . . I just like the package. Because you know, we're staying at the Hotel Marlowe and we just like the fact that, you know we were able to stay and get tickets and--out--out of, you know, our deal. So it was--it was just a nice incentive. (STW2B_DI_040106_CO_1_tr, p. 2, female)***

At COSI, we talked with a mother in her 40s, her boyfriend, and her two sons ages 12 and 8. This group drove an hour and a half from Dayton, Ohio, to see the *Star Wars* exhibition. The

mother, who had learned about the exhibition in the newspaper, said the idea of making a family decision and a family trip was important to her. She and her younger son were the big *Star Wars* fans.

> ***Female: We are from over in the Dayton area. . . . It's about an hour and a half drive to come.***
> ***Male Child (age 8): We're Star Wars fans. . . . We've seen at least--all of them at least 50 times.***
> ***Female: [The decision to come] was kind of the whole family.***
> ***(STW2C_DI_070906_CO_6_tr, p. 2)***

Actual distance traveled varied greatly between the two sites; however, the idea of traveling a substantial distance for an exciting event did not. In general, we found that respondents at MOS gave their place of residence as a location farther away from the site of the exhibition than did those at COSI. Based on other studies, this is probably the result of ongoing visitation patterns of the two institutions and media buys for advertising. It is also influenced by the differences in size of the metropolitan areas in which the institutions are located. On the structured exit survey, we asked respondents for their postal code. We computed distances between the MOS and COSI ZIP codes and U.S. ZIP Codes provided by respondents. Postal Codes outside the U.S. were grouped. These are not normal distributions. A better indication of central tendency is the median. The median distance between the exhibition site and residence was 94 miles at MOS and 25 miles at COSI. That means that about 50.0% of the respondents at MOS came from within a 94-mile radius, and about 50.0% of respondents at COSI came from within a 25-mile radius. About 12.2% of respondents at MOS said they lived outside the U.S.; no respondents at COSI gave this response.

Expectations

Another difference we identified related to expectations about the experience. Soon after we arrived at COSI, in an early debriefing session, we noted there was some difference in what visitors expected the exhibition to be like. While we found *Star Wars Epic Fans* at both sites, we clearly were hearing a high level of expectation for *Star Wars* artifacts and theme-based experiences. At both sites, we heard frequent mentions of media sources where people heard about the exhibition. We talked to staff members to see if they had an explanation for this difference. One explanation we were given was the focus on *Star Wars* character images and film-focused messages in marketing and public information. We collected brochures from COSI and also looked at the differences between the MOS and COSI web presentations. It did appear that the COSI materials featured more *Star War* character images and fewer real-world technology images. We tentatively concluded that some of the differences in expectations were based on the difference in marketing between the two sites.

Effectiveness of Exhibition in Prompting Visits

Through items on the structure exit survey, we explored the success of the exhibition in prompting visits among various groups of visitors. *Star Wars* appeared quite successful in prompting visits. Large majorities of the respondents we talked to in the structured exit interviews said they came to the location that day primarily to see the *Star Wars* exhibition. At MOS, 86.3% reported coming to the museum primarily to see the exhibition, and 72.7% did at COSI. Compared to statistics from other special exhibitions at MOS, *Star Wars* seemed

particularly effective in attracting visits by respondents who had not visited for some time and groups with children under 18 years old. Finally, the *Star Wars* attracted fairly balanced numbers of adult males and females, with about 50% of respondents in each group at COSI and about 55% males and 45% females among the two MOS samples. Data from other special exhibitions at MOS showed differential attraction between men and women. But, in some other important ways, the range of visitors to the *Star Wars* exhibition was fairly narrow. Demographics showed a profile of visitors who were primarily white, well-educated, and with high levels of income. We found only a few people with disabilities in our sample of visitors.

To identify the profile, we compared *Star Wars* samples to other samples of visitors. These samples include 1999/2000 visitors (Museum of Science, 2000) and a sample of *Lord of the Rings* visitors (Opinion Dynamics Corporation, 2004). All structured exit survey samples are rather small. In addition, no raw data were provided to us for other special exhibition samples and overall attendance percentages. It was not possible to run statistical tests except for the three *Star Wars* samples we collected. These findings should be viewed as interesting but not conclusive. Yet, the consistency of the *Star Wars* samples makes a persuasive case for the attraction of this specific audience by the exhibition itself, particularly at science museums and centers with similar visitor profiles to MOS and COSI.

Star Wars seemed particularly effective in attracting visits by respondents who had not visited for some time. In the summative exit samples, respondents who had not visited for over a year were over 50% among both MOS and COSI respondents. For *Lord of the Rings* (LOR) at MOS, this percentage was only about 35% of respondents. In comparison to LOR, Star Wars appears to have been more effective in attracting infrequent visitors to return to MOS.

Compared to the LOR sample (with only 28% visiting in a group with children), *Star Wars* appeared to attract more groups with children under 18. The summative exit samples from MOS show 55% *(n* = 42*)* visiting with children. At COSI 66% *(n* = 32) visited with children.

Summary of Audience of the Exhibition

As we discussed in the introduction to this section, designers of this exhibition had a very clear rationale about attracting a target audience by using the popularity of the *Star Wars* films to attract a wide range of visitors, not just those interested in science and technology and not just fans of the movies. In addition, they designed the exhibition to attract new and infrequent visitors to the museums where it travels. In many ways they were quite successful. The strategy also may have had some unintended impacts. In some characteristics the audience of the exhibition at its first two venues was not broad. But the diversity behind the numbers shows greater range than the quantitative trends might indicate. All the characteristics we discuss in this section influenced how visitors we talked with and observed engaged with the exhibition and what outcomes and impacts the exhibition had on them.

Based on demographics at its first two venues, the *Star Wars* exhibition attracted a consistent and fairly narrow range of visitors. This profile is somewhat consistent with the profiles of science centers in other studies. It has more children as visitors than the profiles of some science museums and natural history museums. Overall, this audience was comprised of about 65.0% of *adults visiting in groups with children* under 17 years old, about 25.0% came in *adult only group*, and about 10.0% *visiting alone*. About 90.0% were white, and compared to the U.S.

population, well-educated and with higher-than-average levels of household income. In terms of ethnicity, about 84.0% identified themselves as white, 7.0% as Asian American, and 9.0% as Hispanic or Latino. The exhibition did attract a fairly balanced number of males and females.

The exhibition was quite effective in prompting visits, particularly among infrequent visitors. Over 75.0% of respondents reported coming to the site that day specifically to see the *Star Wars* exhibition. About 50.0% of the audiences across sites were infrequent visitors. This is a much higher level of infrequent visitors than those attracted to other special exhibitions at MOS.

Within the qualitative data, we found patterns that indicated that the exhibition was more successful in attracting some atypical science center and science museum visitors than it would first appear by looking at the numbers alone. We identified some groups who came to the exhibition with very different meaning orientations toward the *Star Wars* films. Typical science museum and science center visitors appeared more frequently among some of these groups than others.

Among a few visitors we found a group we called *Star Wars Indifferent*. These visitors had accompanied someone else to the exhibition and had very little interest in the films or science and technology. We identified another group, *Star Wars Explorer*s, who were familiar with the films but did not identify intensely with either the action-adventure-technology themes or the narrative elements. Among another group, *Star Wars Adventurers*, we found people who identified with the action-adventure-technology elements of the films. These visitors had high to intense levels of interest in the films. Finally, among *Star Wars Epic Fans* we found high to very intense identification with the narrative elements of the films.

Other audience characteristics have relevance to how people used the exhibition. But we believe these are social roles they brought with them and are more characteristics than simple behaviors. Visitors we classified into a group called *Somebody Else's Visit* were focused but not highly involved with the visit of a companion. These were generally adult visitors with another adult. Some visitors played a role we called *Group Monitor*. Despite their own personal orientation to the films, these visitors focused their efforts on other group member's visits. Members of this group were often parents with children. More mothers played this role than fathers. They often waited in line, attended to younger children, and opted not to use exhibits so others could enjoy access. Another group of respondents we named *Learning Monitors*. These visitors, both mothers and fathers in family groups, watched and assisted children in learning and enjoying the exhibit. They were more likely to engage at exhibits themselves. Finally, we identified a group of *Primary Visitors*. These individuals were focused on their own experiences. Most children fell into this group, and most members of *adult only* groups. Of course *Primary Visitors* interacted with others and influenced each other's experiences.

All these audiences characteristic provide frameworks through which to understand how people engaged with and were impacted by the exhibition experience. The large numbers of visitors attracted to the *Star Wars* exhibition influenced a central contextual factor we will discuss in the section on engagement. On crowded days, respondents engaged less thoroughly and there was less impact. The attraction of groups with children meant there were often large numbers of children in the exhibition. All adults gave priority to children's engagement. The social role

influenced the degree to which people focused intellectually, physically, and emotionally on the exhibition itself rather than on others in their group. This influenced what they did and how clearly they understood the messages of the exhibition.

Engagement with the Exhibition

This section begins with a discussion of overall trends and averages among group of visitors from quantitative methods. It concludes with three vignettes that represent the range of engagement among in-depth interview groups—from low to high.

In our discussion of findings from the quantitative methods, we used the tracking & timing data to provide this big picture view of overall exhibition use. In considering the extent to which and ways in which visitors engaged with the exhibition, we focused perspectives at three levels. At the highest level, the big picture, we considered two quantitative indicators that assess how thoroughly the exhibition was used. These indicators are the percentage of diligent visitors and the sweep rate of the exhibition. Next we looked at the attraction and holding capacity of specific exhibit elements—how may people used an exhibit and how long they used it. Finally, we focused on several specific aspects of the exhibition experience. These include lines, wait time, interactions with staff, and use of the *EDLs*.

Diligent Visitors and Sweep Rate of the Exhibition

We collected tracking data to calculate several indicators of how visitors engaged with the exhibition as a whole. Serrell (1998) developed and standardized indicators that allow us to compare this exhibition to others of similar size. One standard indicator is the percentage of diligent visitors (%*DV*). This is the percentage of visitors who stopped at more than half of the exhibit elements. Another is the *sweep rate index*. The sweep rate index (*SRI*) is the total number of square feet in the exhibition divided by the total amount of time in minutes that the respondents spend in the exhibit (Serrell, 1998, p. 15). Serrell defines an *exceptionally thoroughly used exhibit* as one with 51.0% level of diligent visitors and sweep index below 300.

In general, *Star Wars* showed high levels of diligent visitors and had a low sweep index. These are both positive indicators of exhibition quality. We found that *Star Wars* had very high indicators of visitor use and engagement. The gallery at MOS was 12,000 square feet in size, and at COSI the gallery was 11,500 square feet in size. At MOS visitors spent an average of 57.6 minutes in Star Wars, and at COSI they spent an average of 68.3 minutes. (The length of stay in the exhibition was not significantly different between the two sites.) This means that the *SRI* at MOS was 208 and 168 at COSI.

Respondents stayed an average of 62.3 minutes in the exhibition. At least 50.0% stayed 54.0 minutes. Respondents stopped at an average of 18.4 exhibit elements with 50.0% stopping at least 19 exhibit elements. The MOS exhibition layout had 37 exhibit elements. (We did not include interpretive carts in this calculation because they were not available for use for all visitors we tracked and timed.) At COSI, the exhibition layout had 38 exhibition elements. (We did not include the gift shop in this calculation.) At MOS the percentage of diligent visitors (%*DV*) was 51% and at COSI 50%. The overall %*DV* was 51%. The *Star Wars* exhibition met the criteria for an exceptionally thoroughly-used exhibit at MOS, but COSI fell just short. In general, this exhibit rated quite highly on these criteria. But there was a small difference in how

thoroughly the exhibition was used. Table 2 shows a comparison between *Star Wars* on these indicators and other exhibitions of this size.

Table 2. Behavior Comparisons with Other Exhibitions

Exhibitions*	Number of exhibits	Median percent exhibits stopped at	Average time (minutes)	Sweep Rate Index
Star Wars: Where Science Meets Imagination (MOS)	37	19	57.6	208
Star Wars: Where Science Meets Imagination (COSI)	38	19	68.3	168
Serrell Exhibitions (with 50+ exhibits)	Average = 77	22.0%	19.4	404

Note that stops at each of the *EDLs* (*1.09 Maglev EDL* and *2.12 Robot EDL*) were counted for the exhibit area as a whole, not for individual stations. The designers intended each of the *EDLs* to be perceived as one coherent area. We found respondents did perceive them this way. Given this, it seems an appropriate way to consider the engagement in the context of the overall exhibition. Yet the importance of these areas to the field and to the exhibition requires closer examination of how they were used, which we will discuss in a later section.

Several factors appear to have supported *Star Wars* relatively high overall success on the two indicators. It was a ticketed exhibition, and those experiences for which visitors pay generally have longer lengths of stay than permanent galleries at museums. It also had numerous interactive exhibits of several types, computer interactives, and videos. All these types of individual exhibit elements tend to hold people's attention longer than do static displays.

Demographic Group Comparisons: Number of Stops and Total Time

We made several comparisons among of groups of respondents within the tracking & timing data, to see if the exhibition performed equally as well across sites and among different demographic groups of visitors. We also found small differences between MOS and COSI that appear to be the effect of contrasting decisions about placement of the *Millennium Falcon*. This means the exhibition performed consistently well across both sites. Demographic variables included age, gender, and visiting group type. We found a few minor differences that we believe are related to greater use of interactives by younger adults and children. We made comparisons by using tracking data. We compared groups using two standard indicators, length-of-stay (holding power of the exhibition) and total numbers of stops at exhibit elements by respondent (attraction level of exhibit elements).

In general, we found little difference between location in either time or number of stops. This information across two locations provides confirmation that the exhibition works reliably in a somewhat different configuration and for visitors to a different institution.

How long visitors stayed in the exhibition was consistent and stable across both locations. Generally, with time data in museum exhibitions, a median is a better indicator of all the visitors in a gallery because many people stay only a few minutes and a very few stay a long time. But, in the case of a well-used exhibition such as this one, the average and median times are quite similar. Figures 4 and 5 show the bell-shaped distribution of stops and times that indicate a highly used exhibition.

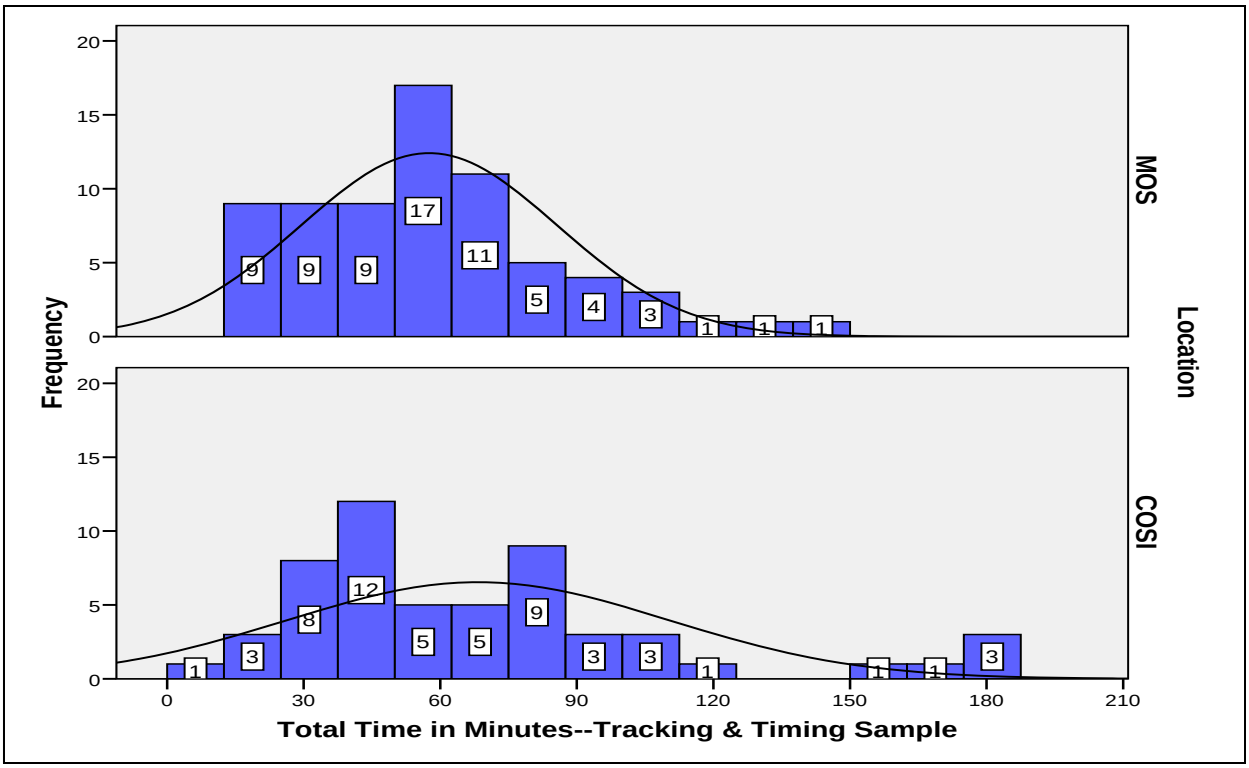

Figure 4. Total Length-of-Stay in the Exhibition (MOS n = 70 and COSI n = 55)

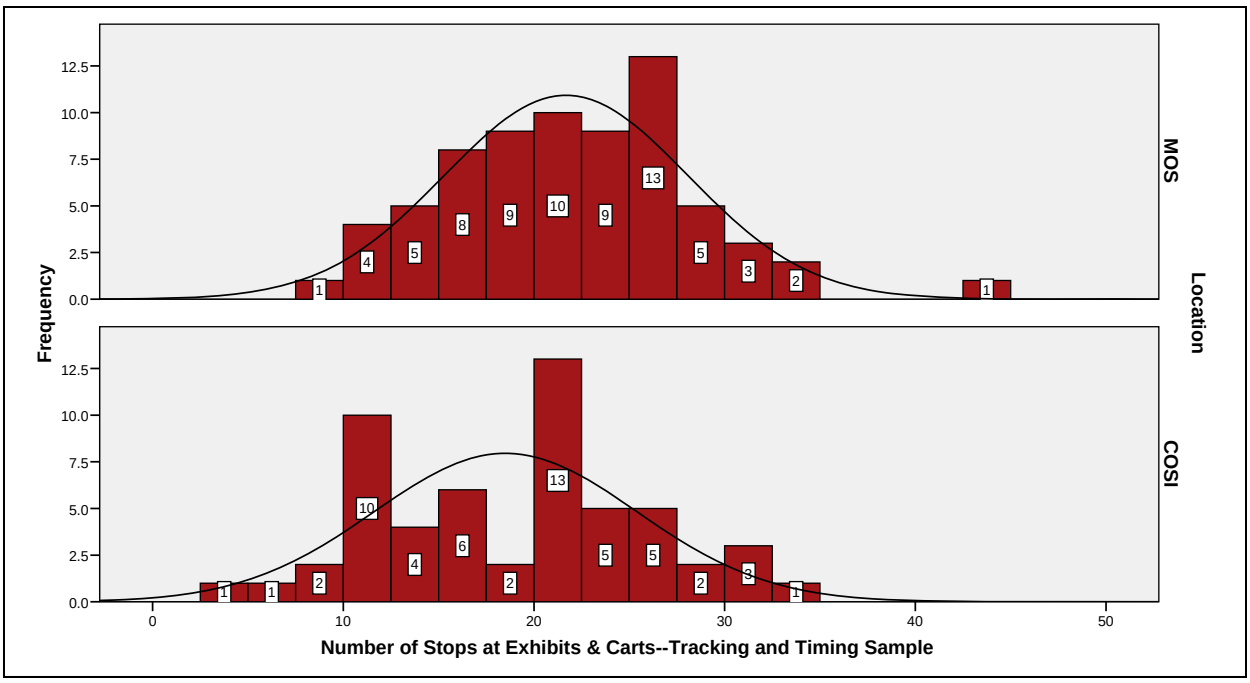

Figure 5. Number of Stops at Exhibits by Respondents (N = 125)

We found one important difference that probably reflects the varying placement of the *Millennium Falcon* at the two locations. At COSI, the average length of stay was 68.3 minutes *(SD* = 41.9, *N* = 55*)*, and the median was 55.0 minutes. At MOS the average length of stay was 57.6 minutes *(SD* = 28.2, *N* = 70), and the median was 54.0 minutes. Those extra minutes at COSI reflect the time respondents probably spent waiting to see the *Millennium Falcon*. The number of stops was not significantly different between locations.

We found some significant differences that we believe are based on greater level of interactive use among younger adults and children. We will present this qualitative data in the sections on how people used the two *EDLs*. We will also discuss this issue in the next section on the attraction and holding of specific exhibits. We found a significant difference between the number of exhibit elements used by relatively older and younger respondents ($p < .05$). In general, respondents younger than 34 years old stayed in the exhibition about 64.8 minutes compared to visitors over 35, who stayed about 58.7 minutes. Respondents visiting in groups *with children under 18* stopped at fewer exhibits than did those visiting in *adult-only* groups. Groups with *children under 18* made an average number of 17.0 stops *(SD* = 6.0*; n* = 80*)* and *adult only* groups made an average number of 21 stops *(SD* = 6.0; *n* = 30*)*. This difference was significant *(p* < .05*)*. All these findings point to the decision to use certain types of exhibits that require longer interactions.

One of the aims of the exhibition development team was to create an experience that appealed across levels of interest and knowledge in science and technology and to the *Star Wars* movies. We described these groups in our section on Characteristics of Respondents. In general, the exhibition appeared to attract people with relatively high overall levels of interest in science and

technology and interest in the *Star Wars* films, but somewhat lower levels of self-assessed knowledge about science and technology. We found only one significant correlation. Respondents with very high levels of interest in *Star Wars* tended to stay longer.

We found that using an MMT had an important effect on engagement. Respondents we observed using the MMT stopped at about the same number of exhibit elements but stayed in the exhibition about 30 minutes longer than those who did not use the tour. Respondents from both sites who used the MMT *(n* = 22*)*, had a length-of-stay of 93.6 minutes *(SD* = 49.3) compared with those who did not use the MMT, with a mean of 54.9 minutes *(SD* = 27.1, *n* = 103). This difference was significant *(p* < .001*)*.

How Visitors Used Exhibit Elements

Bitgood and Shettel (1994) standardized two concepts in the field of exhibit evaluation, attraction and holding. The analyses of the attraction level (percentage of respondents who stopped at an exhibit) and holding level (how long people stayed at the exhibition) tell us a great deal about how people choose to spend their time in the exhibition. Visiting a museum exhibition is sometimes called free choice learning. In a summative study, understanding what influenced visitors' choices (i.e., characteristics of an exhibit, placement in the context of the exhibition hall, and exhibit design characteristics) helps us assess the success of design strategies and provides a guide to future venues about spatial organization.

Exhibit elements in *Star Wars* differed in some important ways. First, at the broadest level, exhibition elements differ by which theme they supported. Table 3 shows the list of all the exhibit elements by theme area.

Table 3. Exhibit by Theme Area

#	***Getting Around*** **theme (transportation) exhibits**	#	***Getting Along with Machines*** **(robotics) theme exhibits**
1.01	Luke's Landspeeder	2.00	Robots and People
1.02A	Ride on a Magnetic Field – video	2.01A-1	SW Robots
1.02B	Real-world Speeders	2.01A-2	RW Robots
1.02C	Electrostatic Lifter	2.01B	Droideka
1.03B	Jumbo Millennium Falcon	2.02	Robot Theater
1.03C	Chewy/Han Case	2.03	Living on Kashyyyk
1.04A	SW Star Ships – Rebel side	2.05A	Static Stability
1.04B	SW Star Ships – Empire side	2.05B	Dynamic Stability
1.05A	Living on Tatooine	2.06A	Living on Hoth – *Star Wars* Side
1.05B	Building Communities	2.06B	Living on Hoth – Real-world Side
1.06	Today's Spacecraft	2.07A	Walking Robot Interactive
1.07A	Living on Coruscant	2.07B	Walking Robot Artifact Cases
1.07B	Moving down the Skyway	2.08	Robot Vision
1.08A	Ride on a Cushion of Air (Chair)	2.09	Expressive Robot
1.08C	Float on a Cushion of Air (Seat)	2.10	*Star Wars* Weapons
1.08D	Armored Attack Tank	2.11A-1	Darth Vader
1.09B	Sebulba's Podracer	2.11A-2	*Star Wars* Medical
1.09C	Maglev EDL – Station 1	2.11B	Human or Machine?
1.09D	Maglev EDL – Station 2	2.11C	Prosthetics and Implants
1.09E	Maglev EDL – Station 3	2.12A	Robot EDL Intro (MOS)/Padme costume

#	***Getting Around* theme (transportation) exhibits**	#	***Getting Along with Machines* (robotics) theme exhibits**
1.09F	Maglev EDL – Parts Bin + Intro	2.12B	Robot EDL Station 1 (Intro COSI)
		2.12C	Robot EDL Station 2
		2.12D	Robot EDL Station 3

At MOS, the Nichols Gallery housed the exhibition. This 12,000-square-foot gallery is located along the front of the museum on the second floor. Visitors can reach this gallery without entering the museum's permanent exhibition halls. The Omnimax Theater is located nearby. A MOS staff member stood at the bottom of the stairs during times of high visitation and asked people to wait until 15 minutes before their ticketed time to come upstairs. Before entering the exhibition, visitors stood in a queuing area with stanchions. At COSI, *Star Wars* occupied about 11,500 square feet of gallery space on the third floor of the building. Box office staff gave visitors a small hanging tag showing they had purchased tickets to this area. Visitors reached *Star Wars* via a central glass elevator or stairs. COSI staff checked timed tickets as visitors entered a long transitional hallway that ran the full length of the exhibition gallery.

Figure 6 (MOS) shows the *Maglev EDL* area located on the upper right hand corner of the map. The *Robot EDL* is shown in the lower left hand corner of the map. At COSI, as Figure 7 shows, the *Maglev EDL* area is located just to the left of the *Robot Theater* near its exit. The *Robot EDL* is shown in the upper right of the exhibition space. Location of these areas, including the angle of approach, played an important role in how visitors made choices about whether to use these exhibit areas.

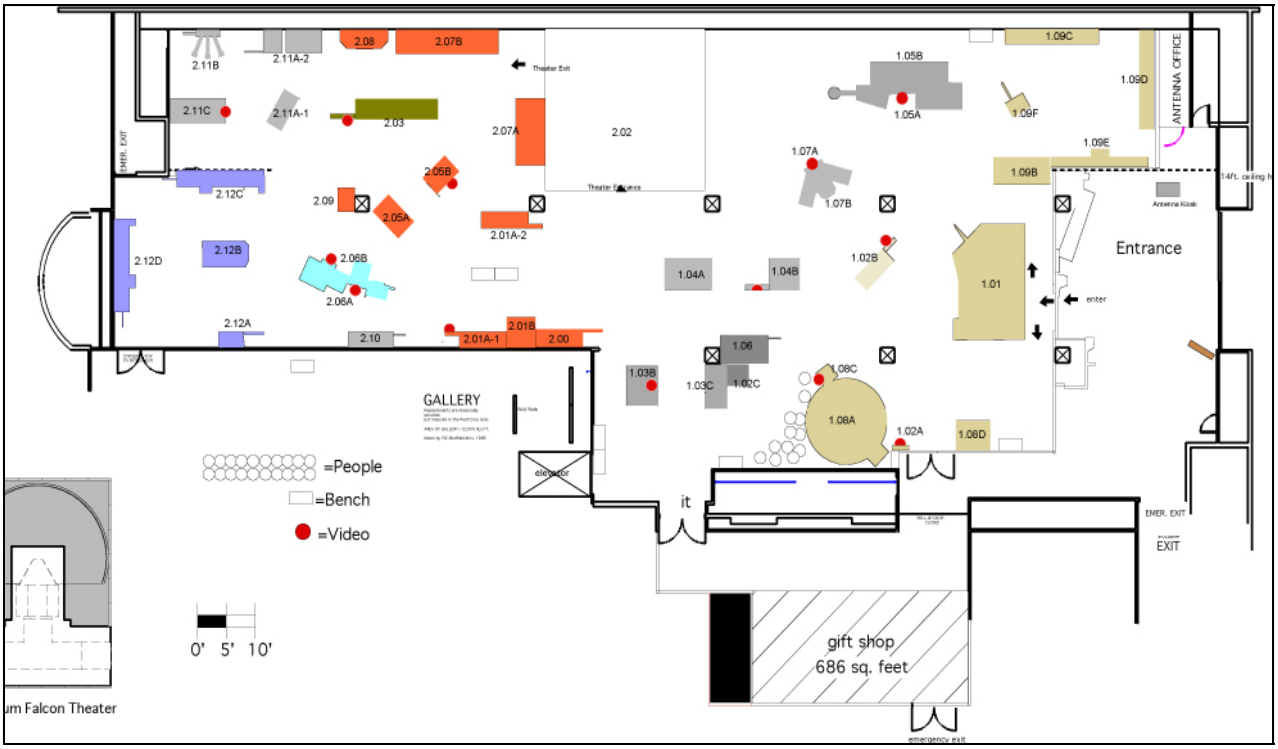

Figure 6. Exhibition Map at MOS

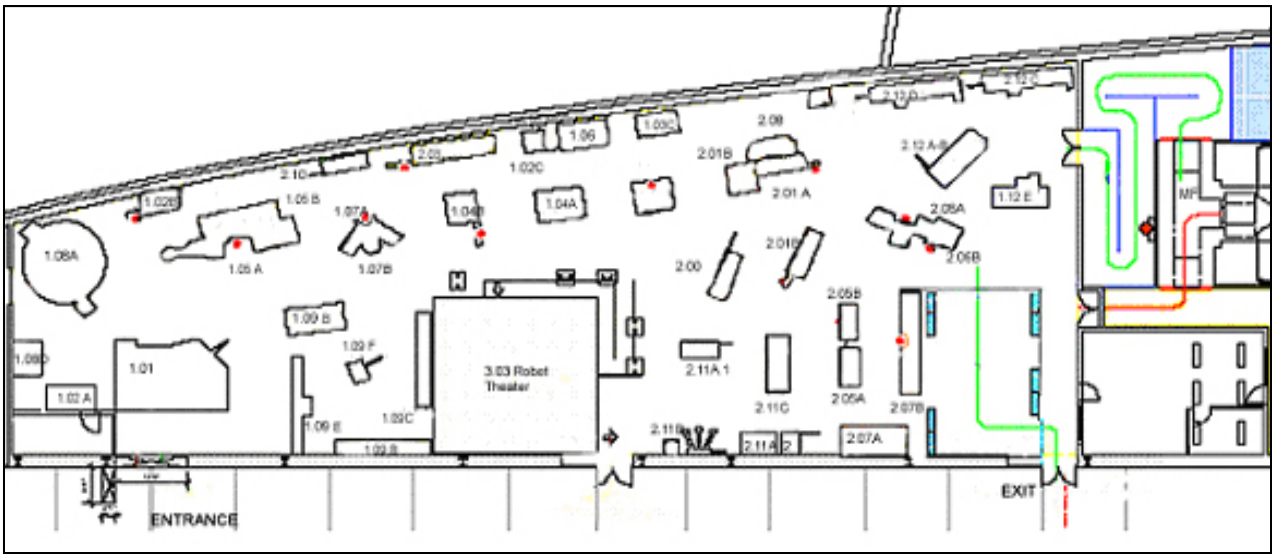

Figure 7. Exhibition Map at COSI

The exhibits also differed by how the design team intended them to be used. The exhibition design team used three types of interactives to support visitor understanding of the engineering design process. This is one of the major goals of the *Star Wars* exhibition. This means that effectiveness of the interactives in attracting and holding visitor attention in the exhibition plays a particularly important role in visitor learning.

The first of these types of interactives are *Engineering Design Labs*. These provide culminating activity for each theme area, *Getting Around* (transportation) and *Robots and People* (robotics including medical applications such as prosthetics). These exhibit areas have multiple stations where visitors are challenged to go through several steps:

> ***1. Create a design by physically piecing together and creating an object from materials that lend themselves towards creating more than one design.***
> ***2. Test that design and assess its success relative to a given goal (which can be a visitor, or, exhibit-generated goal).***
> ***3. Refine or redesign the original creation, by developing a new design that better achieves the visitor's original goal, or works towards a new goal that the visitor came up with based on the results of the testing.***
> ***(Museum of Science, 2005A, p. 19)***

These exhibit elements are part of these areas:
Engineering Design Labs
1.09 Maglev Engineering Design Lab
Station One-Magnetic Levitation
Station Two-Magnetic Propulsion
Station Three-Putting *Maglev* to the Test
2.12 Robot Engineering Design Lab
Station One -- Pick the Right Wheels for the Job
Station Two -- Get with the Program
Station Three -- Use Some Sense

Simple Design Activities are another type of interactive. These activities do not engage visitors in all three steps of a cycle. They encourage visitors to participate in one step: the design process. Simple Design Activities included the following:

1.05B Building Communities
1.07B Moving Down the Skyway
2.05 Static/Dynamic Stabilization
2.09 Expressive Robot

Demonstration/Exploration Activities are the third type of interactive. These exhibit elements introduce context, and present models and issues for visitors to explore. In addition, "They explore relevant science content, and will highlight real-world technologies that might have application to the design challenge for the area." (Museum of Science, 2005A, p. 21). Exhibits in this category included the following:

1.02C Electrostatic Lifter
1.03 Make the Jump to Lightspeed
1.08 Ride on a Cushion of Air
2.01A-2 Robotics Today
2.02 Robot Object Theater
2.05 Static/Dynamic Stabilization
2.07 Walking Robot
2.08 Robot Vision
2.11B Human or Machine

In addition to these types, there are two other important types of exhibition elements. Many of the exhibit elements are artifact cases. Based on previous research, these exhibits show, if placed in accessible areas, that they can have high levels of attraction (i.e., many visitors stop to see them) but low levels of holding (i.e., visitors stay to look at them only a few seconds). In *Star Wars* several artifact cases had videos providing behind-the-scenes information by the developers of the technology used in movie-making. These artifact cases we would expect to have longer holding times. Based on past research, we would also expect computer interactives to have relatively low levels of attraction and longer holding times. Visitors having prolonged engagements at these exhibits hinder other visitors from having access to them. In addition, some visitors simply will choose not to use computers.

With this information in mind, we will present the attraction and holding levels in the *Star Wars* exhibition. Table 4 shows all exhibit elements sorted by attraction ranking across location. The table provides information on the percentage of visitors. We report median stop times for exhibits, rather than the more familiar average or means. The median is a better indication of central tendency for a group of measurements, such as stop time, when the overall distribution is not normal. The median is the point in the distribution below which 50.0% of visitors fall. Time data, such as stop times as exhibits, is not normally distributed. This means that, typically in exhibit attraction data, many short times cluster at the lower end of the range than the familiar normal curve having most measurements clustered in the middle of the range.

Table 4. Attraction and Holding of Exhibits across Location (Sorted by Attraction Ranking) (N = 125)

Element	Attraction		Holding	
	% Stopping	Rank	Median in Seconds	Rank
1.01 Luke's Landspeeder	86.4%	1	77.5	7
1.05A Living on Tatooine	79.2%	2	67.0	10
2.00 Robots and People	71.2%	3	44.0	23
1.07A Living on Coruscant	69.6%	4	53.0	18
1.09 Maglev EDL Total	69.6%	4	146.0	3
1.03B Jumbo Millennium Falcon	68.0%	6	48.0	21
2.03 Living on Kashyyyk	68.0%	6	54.0	16
2.10 *Star Wars* Weapons	67.2%	8	59.0	11
2.11A-1 Darth Vader	64.8%	9	51.0	19
2.12 Robot EDL Total	64.8%	9	133.0	4
1.04B SW Star Ships – Empire side	61.6%	11	35.0	29
2.06A Living on Hoth –*Star Wars* side	57.6%	12	58.5	12
2.11C Prosthetics and Implants	56.0%	13	87.0	5
2.01A-1 SW Robots	55.2%	14	54.0	16
2.08 Robot Vision	54.4%	15	57.5	14
2.11A-2 *Star Wars* Medical	53.6%	16	38.0	28
1.04A SW Star Ships – Rebel side	53.6%	16	24.0	34
1.08A Ride on a Cushion of Air (chair)	52.8%	18	82.5	6
2.07B Walking Robot artifact cases	52.8%	18	38.5	27
1.03C Chewy/Han case	45.6%	20	23.0	36
2.01B Droideka	44.8%	21	30.0	31
2.01A-2 RW Robots	43.2%	22	44.0	23
2.11B Human or Machine?	42.4%	23	40.0	26
2.02 Robot Theater	41.6%	24	900.0	1
1.05B Building Communities	40.0%	25	165.0	2
2.05A Static Stability	40.0%	25	73.0	8
2.07A Walking Robot interactive	40.0%	25	47.5	22
2.05B Dynamic Stability	39.2%	28	57.0	15
1.06 Today's Spacecraft	36.8%	29	48.5	20
1.08D Armored Attack Tank	36.0%	30	23.0	36
2.06B Living on Hoth –Real-world side	35.2%	31	42.0	25
1.02B Real-world Speeders	28.8%	32	58.0	13
1.02A Ride on a Magnetic Field – video	28.0%	33	34.0	30
2.09 Expressive Robot	27.2%	34	69.5	9

Element	Attraction		Holding	
	% Stopping	Rank	Median in Seconds	Rank
1.07B Moving Down the Skyway	24.8%	35	25.0	33
1.08C Float on a Cushion of Air (seat)	23.2%	36	29.0	32
1.02C Electrostatic Lifter	3.2%	37	23.5	35
Cart: Float Like Me, Can You?	0.0%	38	na	na
Cart: Pass the Jedi Trails, Can you?	0.0%	38	na	na
Cart: Sense You, the Robots Can	0.0%	38	na	na
Carts: Man or Machine?	0.0%	38	na	na
Gift Shop Total	na	na	na	na
Millennium Falcon	na	na	na	na

We found remarkably similar levels of attraction and holding for specific exhibit elements at both locations. This indicates that the exhibition operates in a stable and reliable way across locations. That is good news for future venues.

In Table 5, we find some not surprising and expected exhibit ranking in the top 10 on level of attraction. *1.01 Luke's Landspeeder* was a large artifact with a video. It was placed near the entrance at both locations. All these factors explain its number one ranking. Another artifact-video exhibit was number two in attraction rankings, *1.05A Living on Tatooine* focused on all three races on this *Star Wars* planet: humans, Sand People, and Jawas. It included costumes and models as well as graphics of their dwellings that described how they survived the harsh environment. The video compared their homes to real-world examples (Museum of Science, 2005A p. 7). Both the *1.08 Maglev EDL* and *2.12 Robot EDL* ranked in the top 10 in attraction. This is surprising for interactives. Based on in-depth interview explanations, we interpret some of the stops at the area and holding time as adults stopping to watching children use the exhibits. They were both clearly very attractive and had relatively long holding times.

At both locations *2.02 Robot Theater*, a timed presentation had the longest holding time. At COSI, where visitors used the *Millennium Falcon* within exhibition space, this timed experience ranked third in holding power. Also ranking highly in holding at both locations were *1.05 Building Communities*, an interactive virtual reality exhibit with three stations; *1.09 Maglev EDL; 2.12 Robot EDL*; and *1.08 Ride on a Cushion of Air* (referred to by visitors as the hovercraft). We would expect all these interactives to have relatively long holding times. We would not expect to find static displays such as *2.11C Prosthetics and Implants* and *1.01 Luke's Landspeeder* among this group of longer holding exhibits. It appears that respondents were simply quite interested in prosthetics and implants.

Of concern to us are two or three exhibits which hold key elements to the exhibition messages but were underutilized due to placement. *2.11B Human or Machine* ranked 23rd overall. At MOS it was in a corner where few people could find it. At COSI it was placed along the back wall. *1.08C Float on a Cushion of Air* (seat) provides an experience with hovercraft technology for those in wheelchairs. At COSI, it was generally inaccessible because of the lines for *1.08A Ride on a Cushion of Air* (chair). Educational Carts were not on the floor at all times during tracking. While we assume they served a lower percentage of visitors, we observed many people engaging with them when they were on the floor.

Pathways

We mentioned pathways in the previous section to explain the relatively higher and lower holding times of some exhibits. The role of spatial placement of exhibit components is to provide visitors with easy physical access to experiences, to provide visual perspectives that contribute to understanding the content, and to allow social groups to easily navigate the experience together. Sometimes exhibitions are planned as sequential experiences. While this contributes to some learning goals, it is not necessary for others. In the *Star Wars* exhibition exhibit, components were arranged into topical areas to allow visitors to make connections to related content. The content outline described both *EDLs* in a way that implies a sequential order of exhibit use in each theme area:

> ***As the culminating activity of both theme areas, the Engineering Design Labs need to explicate the main challenge laid out for each section, and allow visitors to feel that they have been able to address that challenge meaningfully. (Museum of Science, 2005B)***

At MOS, the Nichols Gallery housed the exhibition. This 12,000-square-foot gallery is located along the front of the museum on the second floor. Visitors can reach this gallery without entering the museum's permanent exhibition halls. The Omnimax Theater is located nearby. A MOS staff member stood at the bottom of the stairs during times of high visitation and asked people to wait until 15 minutes before their ticketed time to come upstairs. Before entering the exhibition, visitors stood in a queuing area with stanchions. At COSI, *Star Wars* occupied about 11,500 square feet of gallery space on the third floor of the building. Box office staff gave visitors a small hanging tag showing they had purchased tickets to this area. Visitors reached *Star Wars* via a central glass elevator or stairs. COSI staff checked timed tickets as visitors entered a long transitional hallway that ran the full length of the exhibition gallery.

However, no primary pathway was planned, and we found none created by the visitors we followed through the exhibits in the tracking study. People moved through the exhibition in a large number of ways. A few visitors appeared to expect a primary pathway. As evaluators collected data for focused observations, several visitors, primarily older adults, walked up and asked about the numbers on the exhibits (one set of numbers was for the *EDLs* and the other for the MMT). These visitors said that they thought the numbers indicated the order in which they were intended to see and use various exhibit components, and several asked for a map so they could see the exhibition "in order." We interpreted their questions and these conversations as a request for some guidance on the "best" way through the exhibition.

While there was no primary pathway, we found several patterns in the tracking data. Attraction tends to be more connected to placement and visitor pathways through an exhibition. Of the total 35 shared exhibit elements, 25 fell within 5 rank orders in attraction at both locations. We found that several of these differences in attraction appeared to be due to pathways and placement. The higher level of attraction for *103B Jumbo Millennium Falcon* at MOS (ranking 2nd) compared to COSI (ranking 14th) appeared to be due to the placement at MOS near the exit to the exhibition—a heavily traveled pathway in the exhibition. *2.11B Human or Machine* ranked 19th at MOS and 32nd at COSI. This exhibit element carries a one of the clearest messages in the exhibition about technology trade-offs. Its placement along the back wall at COSI appeared to

affect the level of attraction. Some exhibits such as *1.02 A Ride on a Magnetic Field* (video) ranked 38th at MOS and 15th at COSI. This appears due to placement in an area away from a heavily traveled pathway at MOS and placement on a heavily traveled pathway at COSI.

Focus on Specific Aspects of Engagement

Waiting in Line

Another impact of the *Millennium Falcon* decision was on wait time. For MOS we calculated an average time in the exhibition that respondents spent waiting as 3.0 minutes *(SD* = 27.8, *N* = 70*)* and at COSI 13.3 minutes *(SD* = 53, *N* = 55*)*. At MOS, 56% of the respondents we tracked and timed spent no time waiting at all, but at COSI this percentage was much lower at 30.2%.

These results appear to be related to decisions about whether or not to wait in line for *2.02 Robot Theater* and *Millennium Falcon.* Deciding to see these presentations contributed substantially to total wait time. Unlike other artifact cases and interactives where visitors stayed as long as the exhibit held their interest, these were timed presentations. For those who decided to see *2.02 Robot Theater*, the mean wait time was quite similar at both locations. At MOS it was about 7.9 minutes *(SD* = 7.8, *N* = 27*)* and at COSI it was 6.7 minutes *(SD* = 5.0, *N* = 25). But the range of these times was very large, from under a minute to over 25 minutes. The level of crowding influenced the wait.

At COSI, where the *Millennium Falcon* was inside the exhibition space, some respondents waited even longer to experience J*ump to Light Speed.* The average wait time among these individuals was 25.3 *(N* = 23*)* minutes. We observed several wait times of over an hour. The longest wait we observed was 78.0 minutes. AT COSI, despite the lines and long wait, the decision about whether or not to attend the *Millennium Falcon* did not affect satisfaction negatively. In fact, this experience appeared to increase satisfaction. Respondents who went to the *Millennium Falcon* had an average satisfaction rating on the structured exit survey of 3.9 *(SD* = .3, *N* = 10*)* compared to those who did not attend, with a mean rating of 3.2 *(SD* = .9, *N* = 15*)*.

We concluded that two factors appeared to reduce the impact of these long waiting periods. First, this experience was located at the end of the exhibition where visitors were likely to encounter it at the end of their exhibition visit. In addition, lines were not visible from all parts of the exhibition. In contrast, the *2.02 Robot Theater* at MOS was located visibly in the center of the experience, and this wait did appear to affect satisfaction in the remedial study. Second, COSI staff provided frequent updates about the wait time as people entered the line and provided games and other activities for visitors waiting in line. These positive attitudes, clear information, and activities appeared to keep visitors relatively happy as they waited.

The information provided by the COSI staff members appeared clear about both the nature of the experience and the anticipated wait time. We observed this message being given frequently, perhaps every five minutes. With permission of one of the staff members, we recorded her informational message for visitors waiting for the *Millennium Falcon*.

> ***It's a four and a half minute show. It's not a ride so it is a show. There are seats inside. It's made to look like the cockpit of the Millennium Falcon, so there are four seats. From the point where you're at right now, I'd say you have about a 40-minute***

wait. So what we do is we do ask if there are more than four people that would like to stand inside, because the fire marshal has said that we could have more than four people inside. So the line will go adjusting to that. If the whole family wants to sit, we just do four inside. If we have more people that like to stand [then the line will move more quickly]. If you do have any questions while you're waiting in line, please just stick your head inside, we're right in there. Do you guys have any questions now, at this moment? There are some puzzles up there that we've placed, so when you guys get a little further in line take a seat on the ground and work with our solar system. All right. Thank you. (STW2C_FOC_071006_CT_S3_tr, p. 1)

We found many respondents among *adult-only* groups who chose not to participate at interactive exhibits because of crowding and wanting to make room for children. As COSI, we talked with a young couple (both 18 years old), who explained why they skipped *1.09 Maglev EDL*.

Male: There were a bunch of people on it. So it wasn't really--
Female: That's the--yeah, that's the biggest thing, why we skipped some things. It's--I mean because it's such a big exhibit and it's new, a lot of people want to see it. So you don't always get a chance to, you know, do some of the really cool stuff. So yeah. (STW2C_DI_070806_CT_3_tr, p.9)

The only other exhibit where respondents had noticeable wait times was *1.08A Ride on a Cushion of Air (chair)*. While the number of respondents we observed in the tracking & timing data was small at both locations (5 at MOS, and 3 at COSI), we observed lines at this visit during our data collection visits. At MOS, we saw primarily children using this exhibit. But at COSI, where safety features had been added, we observed many more adults using the exhibit. Table 5 shows wait times by location.

Table 5. Descriptive Statistics for Exhibit Wait Times by Location—Tracking & Timing Sample

Exhibit	MOS						COSI					
	Mean	*N*	*SD*	Median	Min	Max	Mean	*N*	*SD*	Median	Min	Max
1.08A Ride on a Cushion of Air (chair)	1.5	5	0.9	1.1	0.9	3.0	5.2	3	2.7	6.0	2.2	7.4
2.02 Robot Theater	7.9	22	7.8	4.3	0.9	26.5	6.7	26	5.0	5.2	0.4	21.8
Millennium Falcon							25.3	23	24.9	20.0	0.2	78.0

Inclusion of the *Millennium Falcon* in the main exhibition space at COSI did not decrease respondents' engagement in the rest of the exhibition. In fact, respondents at COSI who decided to see *Millennium Falcon* actually used more exhibits *(20.5 exhibits used, SD* = 5.6, *N* = 20*)* than the respondents who decided not to see the *Millennium Falcon.* (16.*5 exhibits used, SD* = 6.8, *N* = 35).

Similarly both at MOS and COSI, respondents who decided to see *2.02 Robot Theater* saw more exhibit elements that respondents did chose not to. At MOS, *2.02 Robot Theater* attendees used a mean of 19.2 exhibits (*N* = 27, *SD* = 27) compared to a mean of 18.5 *(SD* = 5.7, *N* = 43) for those who did not see *2.02 Robot Theater*. At COSI, *2.02 Robot Theater* attendees used a mean 20.5 exhibits *(SD* = 5.7, *N* = 25*)* compared to a mean of 15.8 *(SD* = 6.5, *N* = 30) among those who did not go to *2.02 Robot Theater*. At COSI, 20.0 % *(N* = 11) of our tracking & timing sample attended both *2.02 Robot Theater* and the *Millennium Falcon*.

Engagement at the *EDLs*

Both *EDLs* deserve special consideration because of their importance to the overall exhibition goals. The exhibition design team stated that one of the goals of this exhibition was as follows:

> ***To illustrate the nature of technology by engaging visitors in activities in which they employ scientific phenomena and engineering design skills to create and test technological solutions to problems. (Museum of Science, 2003)***

Basically, designers aimed to encourage visitors to engage in the engineering design process. The *EDLs* served as an anchor experience for theme areas that provided visitors with this opportunity. *1.09 Maglev EDL* anchored the transportation theme area. *2.12 Robot EDL* anchored the robotics theme area. *Maglev EDL* challenged visitors to design and refine a magnetically levitated car. *Robot EDL* challenged visitors to engage in the design of intelligent machines that could sense and move through the environment. How visitors engaged in these two areas is important for two reasons: (1) the *EDLs* provided the central opportunity to actually engage in engineering design in the exhibition, and (2) the techniques and methods the design team used to develop and refine these experience builds on and expands what we know about how to motivate and maintain active prolonged engagement in museum exhibit experiences.

A few additional remedial changes were still underway as the exhibition moved from its opening venue at MOS to COSI. Some of these changes involved providing extra parts for the two *EDL*s and re-designing some of the parts to hold up to heavy visitor use. At COSI, at *1.09 Maglev EDL*, we noted that some of the Lego pieces had been redesigned to fit onto the car bodies more securely. In addition, all the electromagnet coils were securely covered with Plexiglas. In addition, repetitive voice cues that informed visitors that their cars were in starting position had been replaced with quick mid-toned beeps.

In *2.12 Robot EDL* area there were also several changes. At Station 1 the parts bin had been reoriented to the front of the station with the Introduction Panel for the area attached immediately to its left. The Padme character was moved to another location along the wall. The logic underlying this change was to make introductory information and the parts bin more visible as visitors approached the area and began to use the exhibit. Figure 8 shows the configuration during data collection at MOS and Figure 9 shows the re-designed Station 1 during data collection at COSI. In addition, at COSI the leg attachments for robot bodies had been re-designed. During data collection at MOS, legs would sometimes fall off during operation. In the re-designed version, legs were permanently attached and movement mechanisms on the "feet" could be changed.

Figure 8.The Front of Station 1 of 2.12 Robot EDL during Data Collection at MOS

Figure 9. The Front of Station 1 of 2.12 Robot EDL during Data Collection at COSI

1.09 Maglev EDL ranked 4th overall in level of attraction across both sites, with about 70.0% of respondents stopping at the area. It had a hold time of 146 seconds, ranking 3rd overall. *2.12 Robot EDL* ranked 9th overall in level of attraction, with about 65.0% of respondents stopping. It had a median holding time of 133.0 seconds. Based on other tracking and timing studies we have done, these are considerable holding times for any interactive exhibit. We know from in-depth interviews that many adults may have stopped briefly and decided not to participate at either of these areas.

A clear and consistent theme across all the in-depth interviews was the reluctance of adults to use either of the *EDLs* when they saw large numbers of children in the area. Respondents visiting with other adults told us they did not use the interactives if they saw exhibit area was filled with children.

A 20-year-old early childhood education major from Ohio State University and her date, a 21-year-old physics major, both wanted to use the interactives. He thought *1.09 MagLev* would be fun. They decided not to use either of the *EDLs*.

> ***Female: I felt like all the activities were being taken over. Like there was never any availability for like anybody else to like have a turn. . . . Yeah, because families would come and there would be eight people in their family, and all eight would have to try it. And you know, you could never get in. (STW2C_DI_070806_CO_5 _tr, p 7)***
> ***Male: No, I didn't do it here. So that was kind of the reason I didn't do it is because you know, I'd--and plus again, you know, the kids, I wanted to let the kids do it. And it seemed like there was lines for that. So I didn't want to jump in the line when the kids, you know, and not give the kids a chance to try it out. (STW2C_DI_070806_CO_5 _tr, p 7)***

Improvements to *1.09 Maglev EDL* resulted in somewhat lower levels of attraction and higher holding time at COSI than at MOS. The longer holding time implies that people spend more time using the exhibition. This confirms the effectiveness of remedial changes. But it also means that few visitors overall had access to this challenge. At MOS, our tracking data showed that 80.0% of the respondents we tracked stopped at *1.09 Maglev EDL*, with a median holding time of 124.0 seconds. At COSI, we observed a much lower percentage, 56.4% of respondents stopping at this exhibit area. The median holding time at COSI was longer at 204.0 seconds. This is a significant increase in holding time. [But at COSI many respondents during in-depth interviews told us they skipped this exhibit area because it was full.] On less crowded weekdays, in-depth interview respondents in groups with children under 18 years old reported extended engagements at multiple stations in these areas. This finding was verified through both focused observations at this exhibit and in-depth interviews.

The total percentage of those using no stations at *1.09 Maglev EDL* was much higher at COSI, 54.0% than at MOS 30.0%. The pattern also shows that among those who did stop at COSI, there was some tendency to use more exhibit stations. But our brief focused observations at COSI and the in-depth interview evidence indicate that pressure from other visitors waiting to use the area also influenced how many stations visitors felt comfortable using them.

We found very similar patterns at *2.12 Robot EDL*. We found that 70.0% of those we observed at MOS stopped at *2.12 Robot EDL*, compared with 58.2% at COSI. This exhibit ranked 7th in level of attraction at MOS and 12th at COSI. In holding power, this exhibit area ranked 4th at MOS and 4th at COSI with median holding times of 127.0 and 142.5 respectively. This increase in holding time is not as substantial as that which we found for the other *EDL*. Our focused observations at COSI indicated a predominance of visiting groups with children at this exhibit area, and this is confirmed by in-depth interview data.

In tracking & timing observations we counted the number of stations at which respondents stopped. On the structured exit survey we asked adults over 18 about their experiences at each of the two *EDLs*. This gives us another perspective on the use of the *EDLs*.

At *1.08 Maglev EDL*, among respondents who used this area, 25.3% used one station, 27.6 used two stations, 25.3% used three stations, 14.9% used four stations, and 6.9% used five stations. (This total includes an artifact case connected to the area.) Figure 10 shows this information. At MOS, respondents use an average of 2.3 stations (*SD* = .9), and at COSI 3.0 stations (*SD* = 1.5). We attribute this to the remedial changes made between data collection periods. We watched visitors in this area, and found many groups visited all three primary stations. Most respondents stopped at *1.09B Sebula's Podracer* first, at Station 1 second, Station 3 next, and Station 2 last. In observations in the remedial phase, we noticed that many adults watched or helped a child build a Maglev car. We asked them what they did during the exit survey. Before the remedial changes at MOS, 37.2% of the adults we interviewed said they did not visit the area, about 4.7% said they designed their own cars, 27.9% said they worked with someone else, and 25.6% said they watched someone else. At COSI, 57.6% of respondents said they did not stop in the area, 9.1% reported building their own cars, 3.0% said they worked with someone else, and 21.2% said they observed someone else.

These findings are very consistent with our comments on in-depth interviews. Fewer people used *1.09 Maglev EDL* at COSI, and most of those who did were children. Because the exhibit area generally had sufficient parts and children were successful, they stayed longer. Given the crowding, adults felt uncomfortable building their own cars. It also appears adults did not work with children as often as they did at MOS. The remedial changes improved the exhibit area, but the level of crowding interfered with participation.

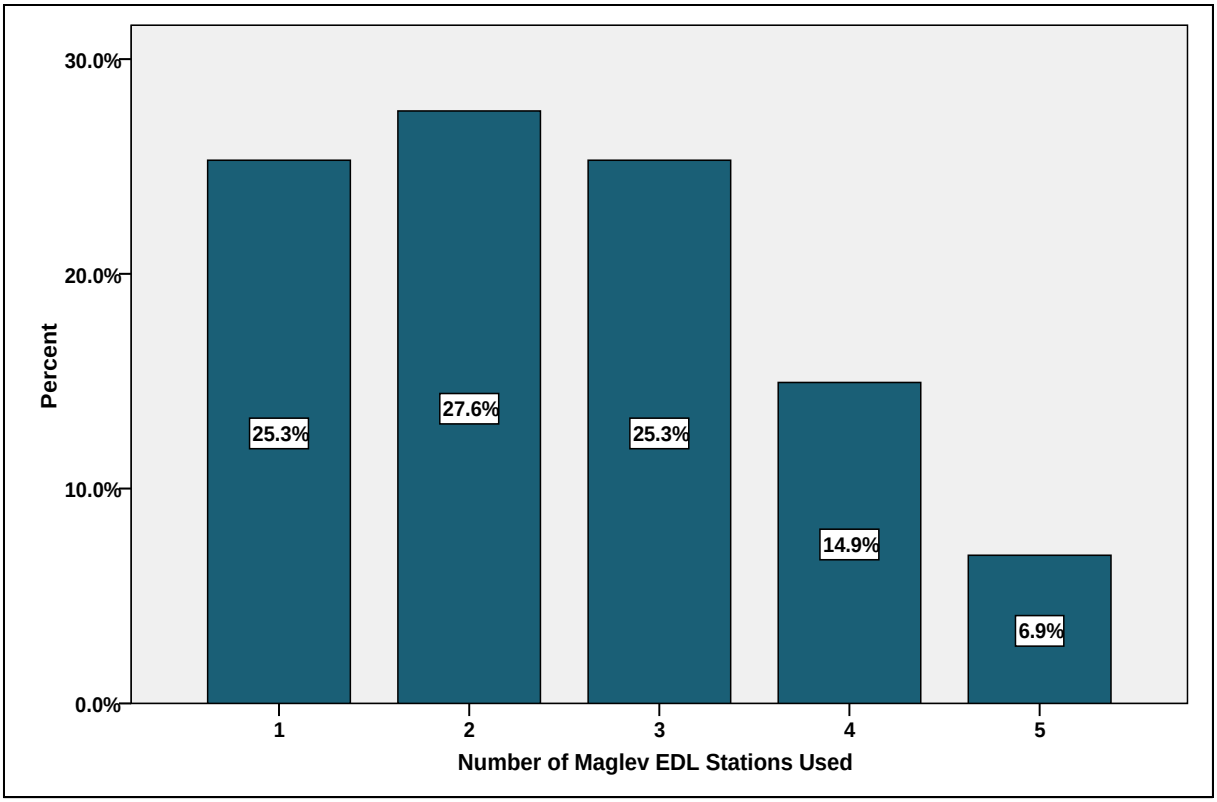

Figure 10. Number of 2.12 Maglev EDL Station Used—Tracking & Timing Respondents (N = 125)

At *2.12 Robot EDL*, 39.5% stopped at one station, 19.6% stopped at two stations, 22.2% stopped at three stations, 14.8% stopped at four stations, and 3.7% stopped at five stations. Figure 11 shows this information in graphic form. At both locations the average number of stations used was about two. The most typical pattern of use was respondents using the *Robot EDL* intro first, Station 1 second, Station 2 next, and Station 3 last.

We also asked people what they had done at *2.12 Robot EDL*. At MOS, 36.4% of respondents said they did not visit the area, 9.1% reporting designing their own robot, 13.6% reported working with someone else, and 31.8% said they observed someone else. At COSI 54.5% of the respondents said they did not visit the area, 6.1% said they designed their own robot, 3.0% reported working with someone else, and 36.4% said they watch someone else. As at the other *EDL*, more adults played observer roles in their children's experience at COSI. We attribute this to the capacity of the area and crowding.

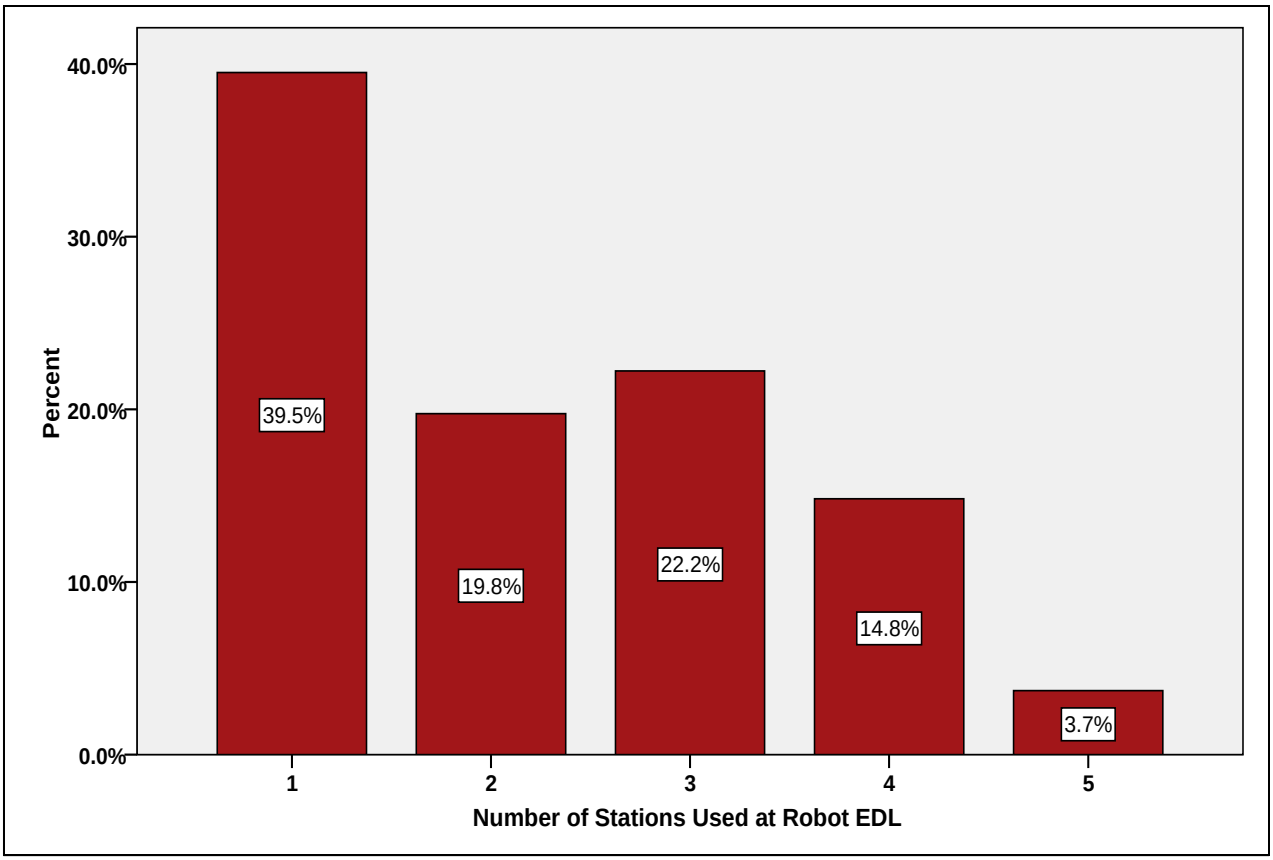

Figure 11. Number of Stations Used at 2.12 the Robot EDL—Structured Exit Survey Respondents (N = 77)

Interaction with Staff

In addition to managing lines, staff members played other important roles in visitors' experiences. Staff members are defined here as people working with visitors--making no distinction between staff members and those volunteers, outside contractors, and internal departments within the organizations. None of the visitors we spoke with made these distinctions. In our experience, if visitors interact with staff on the floor of an exhibition, they perceive them all to be "staff members" and will refer to them as such in the discussion. In this section, we will refer to all people interacting with visitors in the exhibition as staff members. We recognize that some of these people are staff members, some are volunteers, and some are external contractors.

Staff members played both similar and different roles at the two locations. At MOS, staff members took tickets, managed lines at the entrance, managed lines at *2.02 Robot Theater*, served as security guards in the area, and interacted with visitors at interpretive carts. At COSI, no interpretive carts were used, but staff members played all the other roles. In addition, staff members at COSI managed lines at the *Millennium Falcon*. In addition at COSI, an outside

group (but perceived by visitors as staff members) dressed in *Star Wars* character in costumes and interacted with visitors within the exhibition space.

At both locations we found that satisfaction with staff interactions was high for those respondents who had contact with staff members, but at each location there were a few differences. We found differences in both the amounts and type of staff/visitor interaction. On the structured exit survey, respondents were asked to rate their satisfaction with staff member interactions on a four point scale, with 1 = very dissatisfied, 2 = somewhat dissatisfied, 3 = somewhat satisfied, and 4 = very satisfied. We calculated mean satisfaction ratings for MOS of 3.9 *(SD* = 2.7, *N* = 14) and for COSI 4.0 *(SD* = 0, *N* = 13*)*. Even with this very small sample size, this mean difference was significant. *(p*< .05*)*. (Respondents who had not interacted with staff did were not asked to rate their satisfaction.) In addition, we found a difference in the amount of interaction. At MOS a majority of respondents to the Structured Exit Survey reported that they had not interacted with staff. But at COSI, a majority reported that that had interacted with staff. At MOS, 65.1% reported no interaction with staff and 48.5% reported this at COSI. Based on our observations, we believe this is due to the very active line management at COSI and the costumed characters on the floor.

At MOS, the most frequently reported type of interaction was stopping at an interpretive cart (18.2 %), followed by asking for help at an exhibit (11.4%), receiving help without asking (4.5%), and safety issues (2.5%). The safety issue involved help in finding a lost child. Respondents could report multiple types of interactions, so percentages do not total to 100.0%. At COSI, the most frequent type of interaction was receiving help without asking (30.3%), followed by staff providing additional information (15.2%), and asking for help with an exhibit (3.0%).

At MOS, staff members and volunteers brought various interpretive carts into the exhibition space at different times. Not all were present during any one time during data collection. In our tracking & timing sample at MOS, we calculated that 20.0% of respondents engaged at *Float Like Me, Can You? (*ranking 35th out of 41), 14.3% interacted at *Pass the Jedi Trials, Can You?* (ranking 37 overall), 2.9% interacted at *Sense You, the Robots Can* and *Man or Machine?* (ranking 39th out of 41).

Vignettes

These three vignettes provide a view of the range of engagement in the *Star Wars* exhibition. As part of the debriefing process each interview rated the overall level of engagement among the

group of visitors. Levels of impact were rated on each learning goal. These hierarchies are based on ratings learning at individual exhibition developed by Perry (1993). Definitions for levels for this study included,

Definitions for Levels of Engagement

0 ***No indication of any meaningful engagement***

1 ***Minimal engagement, very incomplete use of the exhibition***

2 ***Slightly more engagement but still incomplete/sketchy***

3 ***Basic meaningful engagement. Level 3 is what we look at and say to ourselves "They've saw most things. This is acceptable. It is adequate."***

4 ***More meaningful engagement "They got involved in one or more areas/several areas at a fairly deep level."***

Definitions for Levels of Impact

0 ***No indication of any meaningful impact***

1 ***Minimal impact, very incomplete use understanding and learning***

2 ***Slightly more impact but still incomplete/sketchy***

3 ***Basic meaningful impact. Level 3 is what we look at and say to ourselves "They've got it. This is acceptable. It is adequate."***

4 ***More meaningful impact "They showed a fairly deep understanding or change in several areas at a fairly deep level."***

We selected the three cases below to show the greatest range of engagement and impact from the exhibition experience. Michigan Tourist tells the story of a family from Detroit who we rated as highest in both engagement and impact. *Cleveland Daytrippers* tells the story of a mother and son's visit, which we rated low in engagement and low in impact. Boston Local features a dating couple in their late forties. Their level of engagement we rated at a 3 and impact at about that same level. These are only three of the 32 groups we interviewed, but they involve most of the factors that influenced the level of engagement, satisfaction, and impact of the exhibition.

Michigan Tourist

Michigan Tourists' Engagement

The family included a mother, a father, twin 13-year-old boys, and an 11-year-old girl. They were tourists who had traveled to Columbus, OH, from Detroit, MI (about 130 miles), specifically to see the *Star Wars* exhibition (STW2C_DI_071006_CO_10)[1]. The mother told us that she taught organic chemistry at Wayne State University. The father said that he was a resource analyst with the U.S. Army. The entire family wore *Star Wars* T-shirts to the exhibition and described themselves as big *Star Wars* fans. They had intentionally decided to come to the exhibition on a Monday, when they believed it would be less crowded.

[1] All quotations the Michigan Tourists vignette were taken from transcription document for this data. This decision was made to improve readability.

In terms of satisfaction the children appeared to agree with their parents' ratings which were quite positive.

> ***Male: I could go 8.***
> ***Female: All right, I was going to go 9. The only thing that I'll say about the exhibit is it's crammed into too small of a space. And when we first walked in it was very crowded and I went, oh, this isn't going to be fun. But it seemed to have thinned out as we stayed longer. So I don't know if 11 o'clock was a popular time. Maybe this hour is a little bit lower. We purposely chose a Monday because I thought it would be less crowded. (p. 6)***

They had stayed in the exhibition about 2 hours and 45 minutes. During the interview they described how they used many of the exhibits. The father told us he enjoyed the video interviews.

> ***I really enjoyed all of the interviews with the sound guys--the sound technicians and the artists. And the explanations of where they did things and how they did things and why they did things was really fantastic. (p. 2)***

One of the boys explained how the family used the MMTs and negotiated the exhibition.

> ***Well that's kind of what we did, yeah. And we could each go our own separate ways and see the things that we wanted to see because there, you know, different things drew your attention at different times. So everybody had a chance to go and do what they wanted to do. And then we passed them back and forth. (p. 3)***

All family members took turns waiting in line at the *Millennium Falcon,* including the 11 year old girl.

> ***Female: No, we left her, too. Yeah. Whatever. We shopped and took turns and it was fine. (p. 4)***

The father, mother and daughter went to *2.02 Robot Theater*.

> ***Female: [We didn't wait] long and we took turns again. She and I waited and then they came in when it was time.***
> ***Females Child: Actually we got in line we just--***
> ***Female: It wasn't bad. . . . You had to be--pay attention. (p. 5)***

Neither of the boys went to *2.02 Robot Theater*. They were off on their own in the exhibition. One boy had asked his mother's advice about whether to go. She said:

> ***Female: I wasn't disappointed but I told him he didn't need to see it. So we came out and we said, "You don't need to go in". . . . It was nice, but not to die for. Do you know what I mean? It was--it was okay. . . . Maybe if it was a little bit more exciting. It was--I mean it was informative, it wasn't awesome. (p. 6)***

Both boys had used *1.05B Building Communities.*

> ***Male Child: Well, I like the virtual [reality exhibit] where you had to plan like a community--of like the Jawa camp or the moisture farm and space port. And you had to like sort of make the community out of the tiles. And depending on where you put the tiles it affected how the community ran.***
> ***Male Child 2: I used the same thing as him with the virtual space part and moisture farm. And I didn't really get how it worked but I liked playing around with different locations. (p. 7)***

The 11 year old daughter had used *2.07 Walking Robot.* She called it . . .

> ***Make the guy walk. . . Making the guy walk. . . .***
> ***It was--it was really hard. But I think like if you got to the other side it was really great. Like it was a big accomplishment. (p. 8)***

She had also used *2.12 Robot EDL.*

> ***And I also liked the R2D2, you have to put it together and then you have to like program it to go through the--the field or whatever. (p. 8)***

When asked if she felt like a scientist designing the robot she replied, "Yeah, more of an engineer." She made a clear connection between this exhibit and the process of engineering. When asked to talk about what an engineer does, she said,

> ***They make sure things are working properly. And make sure they're--they do what they're supposed to do. (p. 9)***

One of her 13-year-old brothers had a more sophisticated idea of what an engineer does.

> ***Mine would probably be similar to theirs with making mechanical things and making sure they work properly and repairing them if they need work. You basically think of something that you want to do or what you want to make. And you kind of like make plans for what you want it to look like and what you need to make it. Then you build what you need and test it out. And if it doesn't work you have to go back and redo it and make modifications. And then test it. . . . And then when it finally works you can like mass produce it and create all kinds of different stuff. Or even new stuff from the technology you learned doing one thing. (p. 10)***

When asked if they had seen any real-world technologies, one of the 13-year-old boys replied,

> ***Yeah, the prosthetics. Because they started really simple and then they improved on the design ever so slightly making it even better, like installing computers into the prosthetics to make it more lifelike. (p. 10).***

We found a range of understandings of the Big Idea of the exhibition. The mother, who focused on the technology behind the film-making, described how she would explain the exhibition to a friend.

> ***I would tell them that it's really where science meets imagination and vise versa. Imagination also meets science because a lot of it was the development and the behind the scenes of the technology that went into the Star Wars. So it's more than the story, but it's the special effects and the props and really the behind-the-scenes things. And I think people don't realize the science in the audio and the visual and so much that's digital. And things that were built, the speeder bikes, right, all that stuff. It's all--it really is engineering and science. And people don't realize that. People forget that. (p. 12)***

The father's description was much closer to the intended Big Idea set forth by the design team.

> ***I--it's--I mean Star Wars is science fiction but throughout this whole thing they're telling you that the basis for all this science fiction is something that is real or can be real. The only thing they said that doesn't exist, that is totally fictitious, is hyper space ….Everything else is possible in some form or another. And the fact that there is an inventor who has created a car that will fly through the sky. And then they show you a course on where you're driving through the sky. You know that--it's an everyday thing there. Well it could be an every-day thing sometime here. (p. 12)***

The father identified scientific phenomena behind the Maglev trains featured in the exhibition.

> ***Yeah. Then they talk about the mag train. You know the fact that--and they talk about well how--how did the car levitate? Well you know, the mag train levi - levitates by a magnetic. So there are all kinds of possibilities out there. All you have to do is take what we have a step further. (p. 12-13)***

When asked about the pros and cons of technology, the 11-year-old girl understood this as whether a technology could be made to work.

> ***Well sometimes it can be bad because it can't do like everything you use to do. And like with the mechanical stuff, if like one of the mechanical joints, like if it gets jammed up or something then it wouldn't work as well. (p. 8)***

The father's understanding of the pros and cons of technology were deeper than his 11-year-old daughter's. But these appeared to be ideas he already had when he came to the exhibition.

> ***Well, there are always pros and cons because there's all--there's always the moral aspect of every--of technology of science. So you know, the kids said, you know, that prosthetics can be bad. Well, it's not that the prosthetics are bad, it's their use. (p. 14)***

The 11-year-old daughter drew a picture of *2.07 Walking Robot*. This experience appeared to give her some insight into the effort required in engineering design and the need to test and

retest. One brother drew a picture of the weapons display and the other brother Kashyyyk weapons and tree display.

Analysis of Michigan Tourists' Engagement
Several factors contributed to this family's good experience and positive outcomes. Overall, this group may not rate the highest in impact of all the groups we spoke with, because they came to the exhibit, as a family, with what appeared to be a high interest and knowledge level about the topics. But they clearly had a good time and made deep connections to the content.

They fit well into our group of *Star Wars Adventurers*. They were fans and had enjoyed the movies, but rarely mentioned narrative elements. They were tourists with high expectation, but they were also experienced museum goers. We know this because they compared the MMT to audio tours they had used in other museums. Their experience allowed them to come on a day of the week, a Monday, when the exhibition was less crowded. Economically, they appeared to be well-off as evidenced by purchasing four MMTs. Both parents, but especially the mother, an organic chemistry professor at Wayne State University, had considerable scientific background. Even on a less crowded day, there were lines at *2.02 Robot Theater* and *Millennium Falcon*. This group showed sophisticated "museum-going skills" by taking turns in the line allowing others to shop and use exhibits. They also listened to their MMTs in line, using their wait time in an enjoyable and profitable way.

Overall, the family members stayed a comparatively long time and covered much of the exhibition. Different members of the family made their own choices about which exhibits to use, with the children sometimes going off on their own. How they understood the messages of the exhibition differed, both by age and gender. The father got the intended Big Idea, and the mother appeared to see the technology focus but related it to movie-making. The 11-year-made explicit connections between *2.12 Robot EDL* and real-world engineering processes, but one of her older brothers, at 13, was better able to articulate the process.

Cleveland Daytrippers

Cleveland Daytrippers' Engagement
This mother and her 9-year-old son traveled about 2 ½ hours from Cleveland, OH, specifically to see the *Star Wars* exhibition (STW2C_DI_070806_CT_1)[2]. They visited on a Saturday when it was very crowded. This pair stayed in the exhibition about 40 minutes. From the interview we could only identify two exhibits they had used. The mother told us that she had been looking for fun summer things to do with her son. She said he was a visual learner, and we inferred from this that he might be having some difficulty in school. She said that they didn't go to places like this very often. She explained that she had never heard of COSI until she found a link on the Columbus Aquarium website.

> ***I was just searching on--I don't even remember. But I sort of stumbled on to--I think I stumbled on to the Columbus Aquarium website and then they had a link to the COSI website. So I just started clicking around. And I know Michael is interested in Star Wars. And he's very--he's a visual learner so I thought he would enjoy seeing some of the costumes and props . . . . It's summer and I thought we should get out and see***

[2] All quotes in the Cleveland Daytripper section were taken from the transcript element of this data set.

what's going on up here. To be honest, what drew me was the Star Wars exhibit. And then I--I just started learning more about COSI and the other things they had to offer. So I thought we could spend the day here. (p. 2)

Overall, she rated her satisfaction level somewhat lower than did other respondents we talked with.

I think it was about a 6 or 7. . . . I--it's not Mount Olympus but--But it was interesting to see the costumes. And I--I sort of thought the exhibit would be larger. And I thought they would be like more visual things. (p. 4)

The favorite exhibit for both mother and son saw was the figure of Yoda.

Female: Oh, I liked Yoda--I've always liked Yoda, so I liked seeing--seeing the Yoda costume and stuff. . . . He's my favorite character.
Male Child: He's my favorite character, too. (p. 7)

She told us that they had used *1.09 MagLev EDL* soon after they walked into the exhibition.

I'm not very good at science so I didn't really--didn't really understand the magnet thing too well. I couldn't explain it [to her son]. . . . Right as you walk in the exhibit. The electro-magnet--. . . . Yeah. I wasn't very good at science ever. . . .We couldn't make it work, but it was fun to try. (p. 3-4)

She appeared somewhat frustrated with her experience.

And I didn't know how to make it work. . . . . I did try it. It was right as we walked in. I thought well, let's start with this. It wasn't very crowded at the time. And some of the other older kids were having success. (p. 5-6)

She told the interviewer that they decided not to use *2.12 Robot EDL* because "it was too crowded." (p.6) When asked if they went to *2.02 Robot Theater*, she said,

The line was long. I didn't really know what to expect in there. And so we just walked past it. (p.6)

They also didn't go to the *Millennium Falcon.*

That was cool. . . . We didn't ride it, he was too afraid. . . . . We saw it. Michael wasn't comfortable riding it. And we just looked. (p. 6-7)

When asked how she would explain to someone else what the exhibition is about, the mother said,

That they have big costumes and props from the Star Wars movies. And there are different exhibits to explain the science of--behind the--of how the movie is done or how the--how the--how it was all put together. (p. 7)

Her son said the would tell a friend about the exhibition by saying,

> ***I saw a copy of Yoda. . . . And a copy of Darth Maul and some ships and airplanes. (p.12)***

To try to see if she understood the engineering design process, we asked her to tell us, "What's involved when people design technologies?"

> ***Trial and error, I guess. . . . Trying it and changing it. Change what doesn't work and then try again. I guess science is partly trial and error. And observing what works. And trying to keep--trying to keep what works. And toss out what doesn't work. Change what doesn't work and then try again. (p. 7)***

We asked her if these were things she learned in the exhibition or if she already knew them. She said these were ideas she already knew. When we began to ask her questions about some of the messages of the exhibition she said,

> ***Yeah, and we were mostly interested in the movie connection, as opposed to – (p. 9)***

When we raised the topic of new technologies through a video camera in a home example, she replied,

> ***Whoa. . . . No. . . . My house isn't that interesting. . . . . There's only two of us--I think if I know where I am and I know where he is, then I'm good. (p.10)***

In conclusion, the interviewer asked what she would say if one of her friends asked, "Do you think I should make the two-hour drive?" She replied, "If you go when it's not crowded." (p. 11)

Analysis of Cleveland Daytrippers' Engagement

Both the *Michigan Tourists* and the *Cleveland Daytrippers* had high expectations for the day, but things turned out rather differently for the daytrippers. Probably the biggest difference and strongest factor was that the Michigan family chose to visit on a relatively less crowded Monday, and the Cleveland family attended on a very crowded Saturday. The Michigan parents were experienced museum goers which informed their decision to attend on a Monday. The mother from Cleveland only learned about day-of-the-week crowding from this experience. In addition, the Michigan parents appeared to have rich science backgrounds. The Cleveland mother, apparently raising her son alone, did not see herself as someone who was good at science. The Cleveland mother wanted to play the *Learning Guide* role, but her confidence to play this role was not strong. In addition, her son was younger than the children in the Michigan group. She did identify a scientific phenomenon--the idea that the *1.09 MagLev EDL* involved electromagnetism. Her understanding of the Big Idea of the exhibition was the science behind the movie-making. Both she and her son were focused on the narrative elements of the *Star Wars* films.

Boston Locals

Boston Locals' Engagement
On a relatively less crowded Tuesday, we interviewed a man and woman from Boston. They were in their 40's and they'd come to *Star Wars* to celebrate her birthday (STW2B_DI_040306_CT_10)[3]. Both said they were *Star Wars* fans, but they laughed and agreed that she was the more obsessed fan. She had returned to school to become veterinary technician. He worked in retail but also pursued a career as a writer. They had been to MOS a couple of times before. They stayed in the exhibition about an hour.

The man explained the tickets were his birthday gift to her.

> ***Male: Oh, it was in the paper, you know, a big advertisement for it in the paper. And then it was a birthday gift for her.***
> ***Female: It was my birthday, three months ago. But we just hadn't celebrated yet. (p. 1)***

She explained the delay in coming to celebrate her birthday.

> ***The only thing we had been trying to come to this for months, and the tickets for that always sold out. So we had been delaying and delaying. So he [decided] to like take a day off work, you know, and the place is open until like 5 or 6. So we finally were like okay, we're going to get tickets. And that's what we had to specifically get tickets for was that? Like we could have just showed up. (p.7)***

They both gave the same satisfaction rating, a "7 or 8." The only one thing that would make the rating higher was "more movie stuff." The thing that would make it lower would be "less movie stuff." (p. 7)

> ***Female: We liked the props--all the props.***
> ***Male: --yeah, we came here to see all the stuff that, you know, we knew from the movie.***
> ***Female: I like the costumes.***
> ***Male: Yeah. I would say costumes, too, definitely the best part.***
> ***. . . .***
> ***Male: Just in general. We liked the Wookies.***
> ***Female: Yeah. We liked the Wookies. They were the best.***
> ***Male: And Yoda.***
> ***Female: Yoda.***
> ***Male: Yeah. Yeah. Definitely more than like the hands-on stuff.***
> ***. . . .***
> ***Female: Yeah. We didn't touch the hands-on stuff. We just looked at all the movie stuff.***
> ***Male: Yeah. Really none. (p. 5)***

[3] All quotes in the *Boston Locals* section are from the transcript element of this data set.

They also watched and enjoyed the video interviews.

> ***Female: We watched the videos.***
> ***Male: You know, like we were here more as like fans of the movie. You know. I liked the videos. We watched most of the videos. . . . That went along with the exhibits. You know, where they were talking about how they recorded the sound and stuff like that. Thinking that we came for--more for like a movie perspective than like the science. (p. 4)***

Before coming upstairs to the main exhibition area at MOS, they had paid the additional fee for the *Millennium Falcon*. This was located on the lower level, outside the exhibition area at MOS. They commented,

> ***Male: That--that we were really disappointed in.***
> ***Female: If we were like 5 years old, we would have loved it.***
> ***Male: Yeah.***
> ***Female: But it wasn't at all what we thought it was going to be.***
> ***Male: We thought it was going to be more like--like Universal Studios. Like sort of one of the--***
> ***Female: One of the rides, kind of.***
> ***Male: The fake roller coasters, you know, where you think you're sorting like dipping and stuff, but in actuality you're going nowhere.***
> ***I think that's more what we expected. And it was also way shorter than we expected.***
> ***Female: Yeah. It was very short.***
> ***Male: We--we were under the impression it was going to be like a 20-minute thing and it was like 5 minutes.***
> ***Female: Yeah, when it was over, I was like, wait, that was it?***
> ***Male: Yeah.***
> ***Female: I mean it was only five bucks so it was fine. But we were like, oh. . . . That was it?***
> ***Male: Yeah. Yeah.***
> ***Female: He was almost--we were like that's not--***
> ***Male: We thought maybe we were just seeing the intro or something. But--***
> ***Female: . . . it was only $5, so we didn't mind.***
> ***Male: Yeah. Yeah. If we had paid like $10 and waited in line and everything.***
> ***Female: If it had been more than that--***
> ***Male: We would have been disappointed more. (pp. 5-7)***

We asked if they used *1.09 Maglev* and she replied, "We saw that one but we didn't do it." They both explained,

> ***Female: I don't have the patience to sit there and like figure out I'm supposed to do, I guess. I don't know. It just doesn't --***
> ***Male: Well, I think it would have been more appealing if like, you know, had we been like the age that Legos are like, you know, directed toward--***
> ***Female: I did like the fact that it was Legos, though.***

Male: Yeah.
Female: I was like, oh, wow, Legos.
Male: And I think well, you know, if I was already, you know, really like, you know, at the age where I was playing with Legos I think I'd be more in--interested in like investing time in it.
Male: Like we were--before we came here we were over in like the--like eye- and ear-testing stuff and everything.
We were doing all that kind of stuff.
. . . .
Male: But it's like more, you know, like, you know--. . . . More adult, yeah definitely. (pp.8-9)

Another reason they decided not to use *1.09 Maglev* was that children were using the stations.

Female: And mostly in there it was--tended to be a kid at the stations like that.
So I wasn't likely to go--I don't know--in an area where all the kids were.
Male: Yeah.
. . . .
Female: We just stay away from the kids. I don't know I wouldn't want to block like a little kid from playing with it.
Male: Yeah. . . . . That definitely comes into like--there, you know, like--it--it seems to be geared for them. I don't want to take away their chance to do it.
I know parents only have limited patience; they can only stay in an exhibit for so long. (p. 10)

Despite saying initially that they used none of the hands-on exhibits, we found later that they had used *2.12 Robot EDL*.

Female: That one I liked because it looked like R2D2, really. He's like my favorite.
So I saw that thing and went over to and decided I had to play with it.
Male: The other thing--it was not crowded over there.
Female: But even then--and yeah, there was no one over there. But even then, we didn't stay at that one for long.
Male: Yeah. Just a couple minutes.
Female: We made them roll back and forth.
Male: And we like, oh, there's the invented wheels, okay.
. . . .
Female: [We used the one] where you put the wheels on it. . . . We just used the ones that were already made. And fiddled with them. Yeah, I remember I said to you, oh, look this is where you put the wheels on yourself. And he was like, oh, and he just walked away. (p. 12)

Although they used the exhibit, they did not make connections that using it was a process. When asked to describe how people design technology, they replied,

Male: You mean like were we to like go and try one, what would our thought process be on that?
. . . .
Male: I don't know.
Female: I don't know.
Male: That didn't even occur to me. (p. 15)

We learned that the woman had also decided to ride on the hovercraft at *1.08A Ride on a Cushion of Air*. They did not go to *2.02 Robot Theater* because they had the mistaken idea that there was an additional fee.

Male: That was an add-on, wasn't it?
Female: I thought you paid.
Male: Oh, no, we actually might have done that one if we had known.
. . . .
Male: Yeah, like something you bought another ticket for, the same as the Millennium Falcon or something like that. Oops.
Female: You fool. (p. 13)

They both said that a video on actual magnetically levitated trains was the best thing they saw in the exhibition.

Male: I think the thing that I found the most interesting was the video on the high-speed trains. The Japanese magneto train, or whatever they called it.
Female: Yeah. The Maglev.
Male: That was the most--that was the most where I was like, wow, I never knew that before. (p. 14)
The identified the magnetically levitated trains as a new, innovative technology that they had noticed in the exhibition.
Male: The--the trains. And I liked the--the models of the space stations, too. (p. 16)

When we asked if they would seek out information on Maglev trains, they explained,

Male: I don't know if I'd seek it out, but if it was like on, you know, we watch Discovery Channel and stuff like that. If there was a special on it, I think we'd watch it.
Female: Yeah. I'd watch it.
INTERVIEWER: Do you think seeing what you did today affected your likelihood [to watch] at all?
Female: Yeah.
Male: Yeah. Yeah. Definitely.
Female: I probably wouldn't have watched it before.
Male: You know, I'd heard about them before, but I got like new information from that. It definitely made me more interested in it. (p.17)

In order to see if they understood the Big Idea of the exhibition, we asked them if they were to tell a friend what this exhibit were about, what would they say?

> ***Male: I talked about all the cool memorabilia from the movies.***
> ***Female: Yeah. The props.***
> ***Male: That would be like my main selling point. (p. 15)***

They had also looked at the medical prosthetics areas, but had not used *1.02B Man or Machine*. They did not perceive that they had seen anything in the exhibition on the trade-offs of new technologies.

At the end of the discussion we double checked whether they had understood the Big Idea.

> ***Male: Well, I mean I think our strongest perception was how cool it was to see the stuff from the movie. I mean that was like totally what we were looking for out of the exhibit.***
> ***Female: That's what we wanted. Yeah.***
> ***Male: And that's what we got, yeah. I mean, they had a lot of stuff.***
> ***. . . .***
> ***Female: [We knew] they're trying to show us that Star Wars isn't maybe impossible. That someday in the future that they're trying to--that we have--we might have that technology, but we don't now.***
> ***Female: Yeah, we definitely got that.***
> ***Male: Big time. . . . . It just wasn't our, you know, goal with the exhibit. (pp. 20-28)***

Analysis of Boston Locals' Engagement
While tickets had been challenging to get, and the man in this couple took a day off work, these adults did not display the overall level of excitement that the *Michigan Tourists* did. They were not disappointed or frustrated as the *Cleveland Daytrippers* were. Both members of this couple understood the Big Idea of the exhibition. It simply was not their Big Idea; they came to see the movie artifacts. Yet they participated at one of the *EDLs* and were considerably impacted by the video on magnetically levitated trains. Crowding had some effect on their visit, but it did not overwhelm it. Their decision-making processes, as adults, about not using *1.09 Maglev EDL* were echoed by many other adult visitors.

Summary of Engagement
In this section, we looked at the ways and extent to which visitors engaged with the Star War exhibition. This information allows the exhibition design team to judge whether exhibit strategies and elements functioned as they intended and expected. Along with audience characteristics, it provides a framework to understand the level and nature of outcomes and impacts.

In terms of high level indicators, *Star Wars* was an exceptionally thoroughly used exhibition. We based this finding on Serrell's (1998) standardized indicators, percentage of diligent visitors *(DV%)* and sweep rate index (*SWI*). The exhibition showed remarkably consistent performance across sites. Respondents stayed an average of 62.3 minutes in the exhibition. At least 50.0% stay 54 minutes. Respondents stopped at an average of 18.4 exhibit elements with 50.0%

stopping to observe at least 19 exhibit elements. (There were 37 exhibition elements in the gallery at MOS, and 38 at COSI where *Millennium Falcon* was included in the ticket price and included in the main gallery space.) Most respondents and visiting groups stayed about the same length of time and used about the same number of exhibit elements. There were some small numerical differences. Younger visitors stayed an average of five minutes longer. Respondents in *groups with children under 18* used fewer exhibit elements, an average of 17, compared to *adult only groups.* We attribute both these differences to how different groups used interactives. Across group types, adults gave priority to children using interactives. In *adult only groups,* this meant avoiding the interactives when they saw children waiting to use them. In *groups with children under 18,* this meant adults were more likely to play the social role of *Group Manager* or Learning Monitor than to use the interactives themselves. Even on less crowded days, adults tended to perceive that interactives were intended for children and be less likely to give them a try.

In addition to these high level indicators, we considered attraction and holding qualities, along with pathways through the exhibition. Attraction is the percentage of people who stopped at an exhibit element. Holding is how long they stayed at an exhibit element. Pathways indicate how visitors move through the exhibition space as they stop and use exhibit elements.

We explained that different types of exhibits can be expected to attract and hold at different levels. We identified several artifact displays which could be expected to attract large numbers of visitors, and this expectation was met. These also had substantial holding times. This appeared to be due to video elements and/or interviews with *Star Wars* movie makers in these exhibits that held visitors' attention. We found that the two *EDLs,* designed as important anchors of the two thematic areas, had relatively high levels of attraction and substantial holding times. In addition, we found no primary pathway apart from visitors entering into transportation theme area and exiting from the robotics theme area. Some visitors, particularly older people and those with disabilities, wanted an overview of the spatial and thematic organization so they could make clearer choices about how to spend their time and move through the exhibit space.

A closer look at engagement showed a finer grained picture. Due to the popularity of the exhibition, waiting in line and crowds were central features of many visitors' experiences. Lines were associated with the two timed presentations, *2.02 Robot Theater* and *Millennium Falcon*. At MOS, with only one of these elements in the exhibition space, visitors spent an average of three minutes waiting in line. At COSI, the average wait was much higher, 13 minutes. In addition, many visitors chose not to go to these presentations because they did not wish to wait in line.

Crowding affected engagement at all interactives, but particularly at the two *EDLs*. These important multi-station interactives were designed to provide central anchor experiences for each theme area. They also gave visitors the opportunity to do the entire engineering design process and understand the importance of each step. Many children used the *EDLs* and had good experiences with substantial engagements and used more than one station. Many adults gave priority to children's engagement, and did not participate in these areas. Even groups with children felt pressure to leave the area to allow others to have access to the stations. Adults used more of the artifact-based exhibits, watched the timed presentations, and managed and guided children's visits.

For a close up view of engagement, we used vignettes to tell the stories of three visiting groups with a range of engagement. These vignettes focused on the experiences of three groups that we named *Michigan Tourists*, *Cleveland Daytrippers*, and *Boston Locals*. These stories illustrate the large number of factors that influence the level of engagement in any group of visitors. *Michigan Tourists*, a family group with older children and scientifically confident parents, illustrate a very high level of engagement. These *Star Wars Adventurers* stayed over two hours and used a wide range of exhibits. They were experienced museum-goers and planned their visit for a Monday when they expected the space to be less crowded. *Cleveland Daytrippers* tells the story of a single mother and her 9-year-old son, who both had a low level of engagement. Both were *Star Wars Epic Fans*. The two were infrequent visitors to cultural institutions, and chose to visit on a busy Saturday. The mother had planned the trip from website information and expected more artifacts and visual displays and less science and technology. The mother's lack of confidence in her own scientific and technology capabilities frustrated her attempts to be a *Learning Guide* for her son's experience. They visited under an hour after a 2 ½-hour drive to see the exhibit. At a moderate level of engagement, we chose an adult dating couple in their forties. She was a *Star Wars* Epic Fan and he was a *Star Wars* Adventurer. They had planned this visit for several months to celebrate her birthday and chose an less crowded weekday because of ticket availability. While they claim to be interested only in the film artifacts, they watched videos and used some of the interactives.

This information provides a picture of engagement in the *Star Wars* exhibition. Compared to other exhibits, it was exceptionally thoroughly used. But, groups of visitors made different decisions about what elements of the exhibit to use. Some of these choices were influenced by meaning orientation to the *Star Wars* films, composition of the visiting group, age level of children, expectations about the experience, and social roles. Choices were also influenced by the level of crowding and an overall audience mix with large numbers of children. Adults gave priority to children's use of exhibit and chose not to engage in areas attractive to children.

Outcomes and Impacts

In this section we will discuss how satisfied visitors were with their experience, the extent to which they understood the Big Idea of the exhibition, and the extent to which they understood the primary messages and accomplished the learning goals.

Informal learning environments are designed to provide highly engaging and satisfying experiences that motivate learning in the specific context and continued learning after the experience. Visitors choose to come to institutions who offer these experiences. Once there, they choose what to see and what to do. Satisfaction, whether in the form of fun or of acquiring deep meaning, is often highly associated with the level of learning in informal learning environments. *Star Wars* exhibition designers aimed to create a highly satisfying experience for a broad range of visitors.

In a content outline for the exhibition, the development team clearly set forth the main messages and supporting primary messages of the exhibition. The stated overarching message (or big idea) of the exhibition as "You can have fun using technology skills to design a future, like the *Star*

Wars universe" (Museum of Science, 2005A., p. 17). The exhibition development team had a very clear strategy to deliver this idea and to attract people to visit.

> ***The exhibit will build upon the popular attraction of the Star Wars movies and the release of the sixth and final film in May, 2005, to engage visitors in an exploration of current day science and technological developments that could some day make turn fictions into reality. (Museum of Science, 2005A., p. 3).***

In addition the team identified five primary messages to accomplish the main idea.

> ***• Both real and fantasy technologies begin with imagination.***
> ***What's the challenge?***
> ***• It helps to know something about science to make technologies.***
> ***Can it work?***
> ***• To turn your idea into a technology, you have design, build, test, and refine it.***
> ***How would it work?***
> ***• You need to think about the implications to make good technology decisions.***
> ***Would you want it?***
> ***• New technologies are being created right now that will amaze you.***
> ***How real is it? (Museum of Science, 2005A., p. 17).***

Parallel to these messages were learning goals in six areas. These included using imagination and creativity, exploring scientific phenomena, gaining engineering design skills, understanding impact of technology, exploring current research, and understanding of one's role in future technology. Specific learning goals are included in sections where findings in specific areas are discussed. Structured exit interviews provide overall indications of level and scope of outcomes and impact of the exhibit. Respondents for this method included only adults over 18 years of age. Our findings about children's experiences and learning come from in-depth interviews. For each topic, we present structured exit interview findings first to provide an outline of scope of impact. This is followed by a discussion of in-depth exit interview findings, which provided a deeper understanding of the outcomes and impacts. Finally, we will discuss relationships among different messages and goal areas in terms of groups.

Satisfaction Level

Overall, most respondents reported high levels of satisfaction with their exhibition experience. For a few, some aspects of their visit lowered how much they enjoyed themselves. In our past experience, we have often found a very clear connection between visitors who had high satisfaction ratings and those who learned a great deal. For the *Star Wars* exhibition, we found several sources of satisfaction.

On the structured exit survey the overall satisfaction rating averaged 3.6 *(SD* = .63, *N* = 77*)*. Figure 12 shows the consistency of satisfaction ratings at both locations. We compared this rating across location and group types and found remarkably few significant differences. We found no significant differences across a wide range of visitor characteristics--group type, age groups, educational levels, income, and ethnicity. Ratings were not significantly different

between MOS respondents and COSI respondents. Respondents using and not using MMTs rated the exhibition similarly. We did not find significant differences among respondents' interest level in the *Star Wars* film or among respondents with different levels of self-reported knowledge about science and technology. We consider all these as good indications that the exhibition satisfied a broad range of visitors.

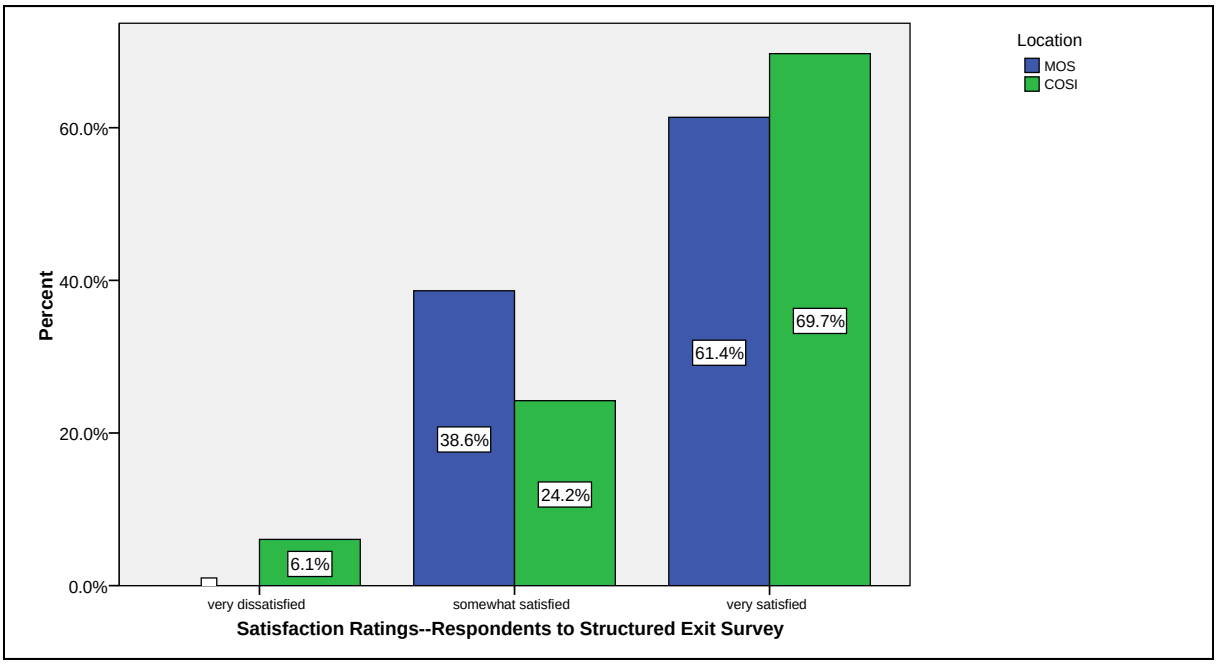

Figure 12. Satisfaction Ratings by Location—Respondents to Structured Exit Survey (N = 77)

We did, however, find significant differences in the level of satisfaction among different levels of interest in and knowledge about science and technology. Respondents with lower levels of interest and lower levels of knowledge tended to rate the exhibition slightly lower than did those with higher levels of reported interest and knowledge. One way to look at the size and impact of this difference is the look at the correlation between the variables. We found significant correlations between satisfaction and level of interest in science and technology at .35 *($p < .001$, $N = 74$)*. This is a relatively low level of correlation, but it is significant. This means that level of interest in science and technology did influence respondents' satisfaction, but the effect was not large. We also found this to be the case with level of knowledge. The correlation between satisfaction and level of knowledge was .35 *($p < .001$, $N = 75$)*. This means that the respondent's level of knowledge of science and technology did influence satisfaction. But the effect was not large. We found that interest and knowledge ratings were themselves significantly correlated at a moderate level, .48 *($p < .001$)*. This means that the same people who rated one highly tended to rate the other highly. We can conclude that respondents with higher levels of interest in and knowledge about science and technology tended to be more satisfied with the exhibit experience than other people who visited.

In in-depth interviews we found a broader range of ratings of satisfaction—no one rated the exhibition lower than a "6" on a 10-point scale, with "1" low and "10" being high. But one influence on these somewhat lower ratings was the respondent's own visit agenda and

expectations. During in-depth interviews we found a high level of expectation for *Star Wars* props and artifacts. The comparative frequency of these comments at COSI compared to MOS sent interviewers off to find an explanation. Interviews and analysis of materials led to our tentative conclusion that marketing messages and materials at COSI appeared to be more focused on the movie props and artifacts. As one grandfather at COSI remarked,

> ***I was kind of hoping to see more* Star Wars *rather than you know the application to the* real-world *was interesting, but I was kind of hoping for a little bit more when I went in there. I'm not--I'm not really sure, but something more along the lines of Star Wars rather than like robots and technology. (STW2C_DI_070806_CO_1 _tr, p 6, male)***

Overall, the Star Wars characters, costumes, and props contributed substantially to very high ratings of satisfaction. But among some adult visitors, we found some clear perceptions that the science and technology content of the exhibition was for children. They had come specifically for the film artifacts. While they were satisfied with the exhibition and we found evidence they picked up new information, they said they wanted more artifacts and less focus on science and technology. This discussion among an interviewer and two of four male respondents in their late teens and early 20s illustrates this point. The interviewer asked them to rate the exhibition on a scale of 1 to 10, with 10 being high.

> ***Male 1: I would give it a 9 and a half.***
> ***Interviewer: Why?***
> ***Male: I enjoyed it. It was cool. It made me feel like a little kid again. But I just wanted to see a little bit more. I mean, you can--you can never have too much of a good thing.***
> ***Interviewer: Okay.***
> ***Male 2: 7 and a half.***
> ***Interviewer: And give--give me your rationale on that.***
> ***Male 2: Like I--I really loved it but I thought it could be more immersive, just what we talked about earlier. You know, just more things to make you feel like you're there. I--I thought the science aspect was really, you know, in teaching kids. But I--I--I guess I more came because I love Star Wars. I really didn't come for the science aspect, which was cool but--***
> ***Interviewer: So you identified the science aspect as for children?***
> ***Male 2: Yeah. Well a lot of it's stuff that we've heard about before. You know, they talked about different parts of the solar system. And you know a lot of that's not really new for us. (STW2C_DI_071006_CT_5_tr, p 8)***

But, for many respondents, the *Star Wars* theme and its connections to technology made sense and added to the things they learned about real-world technologies.

> ***Because, oddly enough I think in a real sense that--what makes the movies kind of enjoyable, was kind of thinking, oh, you know this kind of stuff really sort of exists. You know, and they've kind of taken a look at that. So I think the stuff with the hovercraft and the Maglev trains really sort of nailed that. You know it seems kind of***

fanciful to watch it on the big screen. But, you know, there are folks that have taken a real serious look at it and seen you can have a positive impact on--on how we're living our lives. (STW2B_DI_040106_CO_1 tr, p. 5, female)

The other influence we found on satisfaction was the level of crowding at the time of the visit. This was a strong theme that ran throughout the interviews at both locations. As one 11-year-old boy at COSI explained when asked why he rated the exhibition as a "6" rather than more highly:

Because like you--there's a lot of things you can do in there but like some of it you -- most people are on there so you don't get to do a lot of things. They should like put less people in there at a time. (STW2C_DI_071006_je_1_tr, p. 3, male, age 11)

A couple decided not to use the *1.09 Maglev EDL* and expressed some regret at not being able to use it.

Female, adult: You know, there was always, you know, some, you know, some child just there.
Male, adult: And then like another child -- another child came, you know, came over and so I had to leave it alone. I feel likes it them -- for them more than for me. (STW2B_DI_040106_CO_1 tr, p. 5)

Finally, we found that different people found different things satisfying. For this visitor and several other parents and grandparents, watching other children was the primary source of her satisfaction.

The wide-eyed enthusiasm [of children] That's what caught my attention also. That's what with my baby, but. Just, you know, looking at the kids, you really get a kick out of it and you really enjoy it. You know, that they could actually touch and feel and try to be part of the exhibit. You know, that I like. . . . I didn't really do them. I was more interested in the costumes. And I thought how cool that real people, you know, actually wore that. (STW2B_DI_040106_CO_1 tr, p. 6, female)

The Big Idea

The source of satisfaction in the exhibition was closely related to how the respondents understood the Big Idea. The discussions of the Big Idea of the exhibition featured in the vignettes provide some of clearest understanding of this issue. Many respondents clearly understood the Big Idea, but it was not their reason for coming to the exhibition. The Big Idea of the exhibition stated in the content outlines is "You can have fun using technology skills to design a future, like the *Star Wars* universe" (Museum of Science, 2005A., p. 17).

To assess how well adults understood the Big Idea of the exhibit, we asked similar items on both the structured exit survey and during in-depth interviews. We asked respondents how they would explain what the exhibition was about to a friend. Responses from the structured exit survey were coded into three categories: (1) imagination and *Star Wars* and real-world technologies (i.e., the intended Big Idea of the exhibition design team), (2) *Star Wars* movies—props and costumes, and (3) nondescriptive comments and suggestions.

Responses to this item were significantly different by location. At MOS, 50.0% of the descriptions included ideas about imagination and *Star Wars* and real-world technology; 31.0% described the exhibition as being about *Star Wars* movies, props, and costumes; and 19.0% were comments and suggestions. At COSI, only 21.9% of the descriptions included the association between imagination and *Star Wars* and real-world technologies; 49.9% described the exhibition as being about *Star Wars* movies, props and costumes; and 31.3% were comments and suggestions. One again, we believe this difference may be related to different expectations at the two locations.

Other exit survey items provided additional information about the relative salience of movie themes and science and technology content in the exhibition. Most respondents, at both sites, appeared to find memorable aspects of the exhibition related to both the *Star Wars* movie theme and specific content area themes. We coded up to three "memories" from open-ended items on the structured exit survey.

Exhibit Content Categories

- *Content Category 1. Future Technologies and Real-World Technologies*. Memories included statements about the connection between *Star Wars* and real-world technologies, future technologies, and science/science concepts (general).
- *Category 2. Transportation Theme*. Memories included *Luke's Landspeeder, Millennium Falcon, Maglev EDL, Millennium Falcon Theater*, hovercraft, spaceship models, *Dynamic Stability*.
- *Category 3. Robotics Theme*. Memories included medical area, robotics/robots, medical, technology, *Walking Robot, Robot Theater, Robot EDL*, light sabers, weapons, prosthetics.
- *Category 4. Habitats and Environments Theme*. Memories included environments/technology, computer games (virtual reality*), Living on Tatooine*.

Movie Memory Category

- *Category 5. Movie Memories*. Memories included statements about props, costumes, characters' names, movie memories, and special effects techniques.

Exhibit Techniques and Social Context

- *Category 6. Exhibit Techniques and Social Context.* Memories included response of children to exhibits, volunteers in *Maglev*, closed captioning, hands-on/interactives, MMT, gift shop, negative bad time, positive/good time, too crowded, long lines, short of parts/interactives.

Unclear

- *Category 7. Unclear Meaning*. Memories as recorded could not be connected to any other category or data collector writing too unclear for data entry.

Table 6 shows aspects of the exhibition that respondents found memorable by location. The only apparent differences are a somewhat lower percentage of respondents citing elements related to the robotics theme at COSI than MOS. We believe this was due to the placement of this theme area and the competition for time and attention from the *Millennium Falcon*. This finding is consistent with tracking & timing data. We found memories related to the movie theme of

exhibition at 76.0%, the highest overall, followed by memories related to the transportation theme of the exhibit at 64.9%. At a somewhat lower level, 42.9%, respondents cited aspects connected to the robotics theme.

Table 6. Number of Memories by Category—Respondents to Structured Exit Survey (N = 77)

	Location		
Memory Category	**MOS (n = 44)**	**COSI (n = 33)**	**Total (*N* = 77)**
Future and real-world technologies	13.6%	6.8%	11.7%
Transportation theme	59.1%	54.5%	64.9%
Robotics theme	52.3%	31.8%	48.1%
Habitats and environments	11.4%	6.8%	10.4%
Design and social context	38.6%	36.4%	42.9%
Movie-related	77.3%	56.8%	76.6%
Unclear	0.0%	9.1%	5.2%

To prevent misinterpretation of these findings we looked at this data in another way. Of course the movie-related memories were very prominent. This was part of the exhibition strategy. The real question was whether both the movie connections and science and technology connections were prominent features of the experience. We counted the number of memories that related to the technology themes of the exhibit and those that were exclusively movie-related. Less than 20.0% of these adult respondents cited no content related memories. A majority, about 74.1% across both locations cited either one or two content-related memories. A few respondents at each location, about 10%, focused exclusively on content. Table 7 shows these percentages by location. Tables 7 and 8 show the number of film-related memories and exhibit technique and social context memories respectively.

Table 7. Number of Content-Related Memories (1-4) by Location—Respondents to the Structured Exit Survey (N = 77)

	Location		
# Content	**MOS**	**COSI**	**Total**
0	18.2%	11.4%	16.9%
1	38.6%	31.8%	40.3%
2	31.8%	27.3%	33.8%
3	11.4%	4.5%	9.1%

Table 8. Number of Film-Related Memories (#5) by Location—Respondents to the Structured Exit Survey (N = 77)

	Location		
#Movie	**MOS**	**COSI**	**Total**
0	34.1%	27.3%	31.2%
1	54.5%	69.7%	61.0%
2	11.4%	3.0%	7.8%

Messages and Learning Outcomes

Among adults, respondents appeared to have the clearest understanding of the role of imagination and creativity in technology design. Second in overall strength was the idea that there are current, real-world technologies similar to those in the *Star Wars* films. At somewhat lower levels of understanding were the importance of knowing about scientific phenomena in technological design and the importance of understanding trade-offs in making decisions about new technologies. Lowest of these five messages were concepts about the engineering design process and the extent to which visitors felt empowered to actually give it a try. Data for the findings come primarily from two sources. The structured exit survey provides quantitative information and in-depth exit interviews provide qualitative data.

Figure 13 provides a good picture of the relative levels of message strength in the exhibition among adults. We asked respondents to rate the degree to which they found new and exciting things in the exhibition in each of the five major message/goal areas. They rated the items on a 10-point scale, with "1" being low and "10" being high, Adults over 18 who responded to the structured exit survey provided the information on which the graph is based. But all methods support this overall finding. There were some important differences in which members of the audience were more or less affected in each of these areas. The respondent's meaning orientation toward the *Star Wars* experience, social role in the visit, and expectations about exhibit experience all influenced the degree to which they understood primary messages. There were also some important differences between adults and children. These are highly associated with the differences in exhibits used by adults and children, even those in the same visiting group.

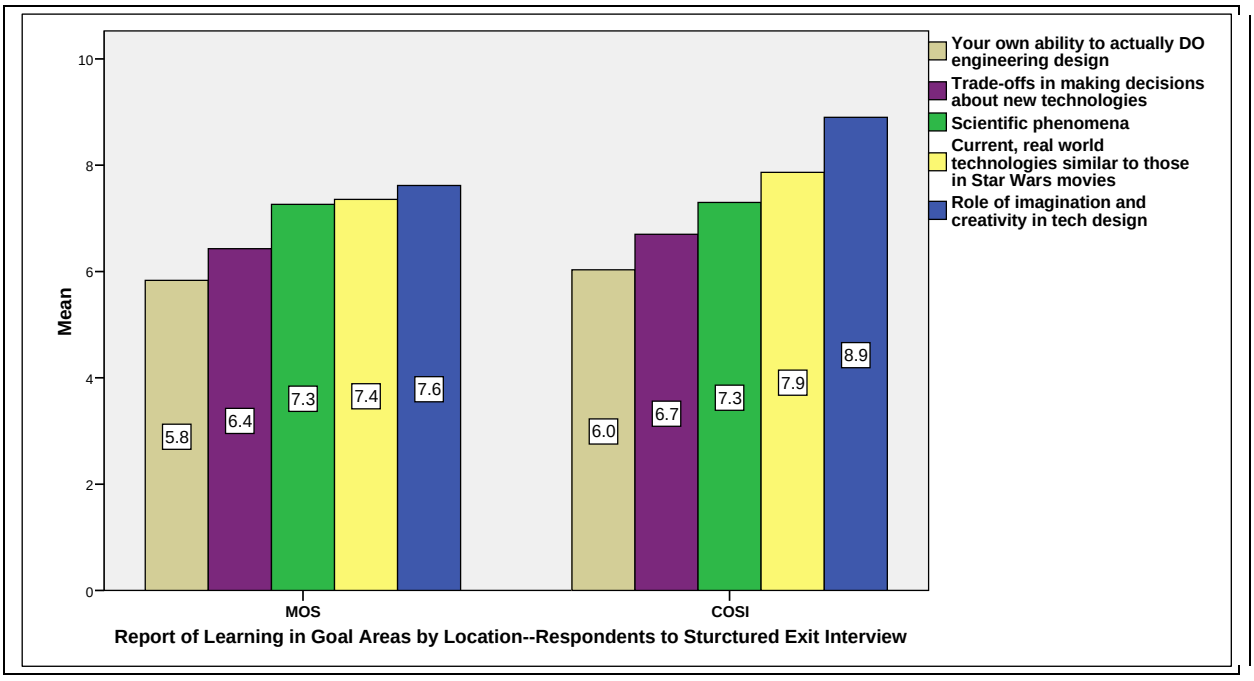

Figure 13. Report of Learning in Goal Areas by Location—Respondents to Structured Exit Survey (N = 77)

Imagination and Creativity

Learning Goals
Recognize that technology is closely linked to creativity which has resulted in innovation.
Identify that everyone can design solutions to a problem.

Respondents rated the role of imagination and creativity in technological design the most highly among this group of items at 8.2 (*SD* = 2.2, *N* = 75).

This topic arose frequently in in-depth interviews sometimes in relation to the Big Idea and in other references throughout the interviews. The Michigan Tourist mother's Big Idea of the exhibition is a good example. While the imagination part of this message was clear, the extent to which respondents made connections to creativity depended on their Big Idea of the exhibition. Some evidence was in the tone used in explanations like this 10 year old boy explaining how he understood the exhibition.

> ***I think it was definitely about technology, robots, space travel, those types of items about how we may learn and improve our ways through those types of things. They had the whole airplane ride you can be there, get on the roof and fly home. (STW2B_DI_040206_CT_4_tr, 17, male age 10)***

Current Research

Learning Goals
Remember topics and processes of current research they saw in the exhibit.
Identify ways to follow current research topics and processes.

Seeing new and exciting things in the exhibition about current and real-world technologies similar to those in *Star Wars* movies ranked second among the primary messages. Respondent ratings average 7.6 (*SD* = 1.8, *N* = 74). Among all the goal areas, this one was highest for adult respondents in in-depth interviews. Almost all the adults could cite interesting new and innovative technologies they had seen. Some clearly expressed the intent to follow up on their interest.

One woman, who we categorized as a *Group Manager* and as a *Star Wars Epic Fan* surprised us near the end of the interview by reflecting on taking a class to follow up an interest in the exhibition.

> ***If I'm curious and I don't understand, you know, the principle behind it, you know, they will have to break it down. Because I'm not -- I'm more of a social science person. You know, I'm not the scientist . . . Well, it's interesting. I mean, it makes me want to, you know, take a class. I mean if I had the time, you know, I would love to, you know, sit in a class learn more about, you know, the science behind it. You know, like take a physics class. You know, take a computer class. Because I know like they have like things like, you know, 3D animation. (STW2B_DI_040106_CO_1 tr, p. 19-24, female)***

Two other mothers who also played the social role of Groups Managers also said they would find out more about a topic in the exhibition.

> ***Female 1, adult: I would probably go to another exhibit on robotics.***
> ***Female 2 adult: It's something I always think about -- oh, the kids -- like I know there's an MIT Museum that has some robotics and stuff.***
> ***STW2B_DI_040106_CT_2_tr, p. 21)***

But a few expressed not connecting to new and innovative technologies. Another *Group Manager*, a mother who had volunteered to wait in all the lines for her children and husband, said,

> ***I don't know. I don't know. I didn't really think about it. . . . But it's enough to make you want to go get the collection -- the whole collection of Star Wars on DVD. (STW2B_DI_040206_CO_2_tr, p. 25, female)***

Exploring Scientific Phenomena

Learning Goals
Remember and identify the scientific phenomena encountered in the exhibition.
Recognize that experimentation (exploration of scientific principles), which is common in science, can also be used to solve technological problems.
Show a willingness to experiment in the testing and evaluating of solutions for design problems.

Scientific phenomena ranked third with an overall mean rating of 7.3 (*SD* = 2.2, *N* = 75). We also asked respondents to cite scientific phenomena that they would remember. We intended this item as a way to assess what ideas and concepts respondents were taking with them from the exhibition. In analyzing both exit survey and in-depth interview responses, one thing was very clear: People made few distinctions between science concepts and technology concepts. Overall, this was the interview question for which we got the most vague and diverse responses. Table 9 shows the range of topics from respondents to this item.

Table 9. Science Concept—Respondents to the Structured Exit Survey (N = 67)

Science Concept	Location		
	MOS (*n* = 39)	COSI (*n* = 28)	Total (*N* = 67)
New technologies and engineering design (broadly stated)	0.0%	10.7%	4.5%
Robotics	51.3%	28.6%	41.8%
Medical technology	51.3%	39.3%	46.3%
Transportation technology	94.9%	57.1%	79.1%
Environmental implications	5.1%	14.3%	9.0%
Weapons	2.6%	0.0%	1.5%
Interactives	2.6%	7.1%	4.5%
Movie making	7.7%	7.1%	7.5%
Other/unclear	2.6%	14.3%	7.5%
*up to three items were coded, so percentages do not total 100.0%			

We asked the respondents to the structured exit survey two items to assess the degree to which they had been motivated to follow up on topics in the exhibition. One item asked them to rate, on a scale of 1 *(low)* to 10 *(high,)* how likely they were to explore any of the scientific phenomena they had seen in the exhibition.

Impact of Technologies

Learning Goals Recognize that decisions about the use of technology involve weighing trade-offs between positive and negative effects. Articulate the tradeoffs of using a product or a system and make a decision when it could be used.

Ranked fourth among the new and exciting things they learning in the exhibition were trade-offs in making decisions about new technologies, ranked fourth with an average rating of 6.5 (*SD* = 6.5, *N* = 73). Another exit item asked them to rate, on the same scale, the extent to which they thought they would be likely to explore the trade-offs in new technologies. Overall, respondents rated this likelihood of exploring scientific phenomena at average of 5.6 *(SD* = 2.8, *N* = 72*)* and trade-offs in new technologies at 6.5 *(SD* = 2.6, *N* = 74*)*. We found a significant difference between these two ratings *(p* < .001*)*. This rating appears to confirm, in the context of the other findings that respondents saw the focus of exhibition to be more clearly about technology than about what they considered science. On most group comparisons, we found no significant difference on either of these ratings. We found no consistent pattern of difference by age levels, income levels, or location.

We found patterns in the ratings of exploring trade-offs by group type and level of education. Respondents with higher levels of education tended to rate this item more highly than those at lower levels. When we examined this pattern closely, it appears to have been skewed by the higher levels of education at MOS—at the graduate and doctoral degree levels. While it was not significant by location, these group comparisons based on small samples can mask underlying patterns in the data.

We found a more important and stable pattern on the exploring trade-offs rating based on group type. Respondents visiting in *groups with children under 18* years old rated this item at an average of 7.2 *(SD* = 2.4, *N* = 43*)* compared to an average rating of respondents in *adult-only groups* and *alone* 5.7 *(SD* = 2.7, *N* = 30*)*. We did not find this pattern in the remedial study. We found a relationship between this finding and two other factors, but only in the qualitative data. We found a tendency among some of the adults we interviewed to perceive the science and technology content and the interactives in the exhibit as aimed toward children. We also found some adults, particularly those in *adult only* groups, came to the exhibition primarily to see the *Star Wars* artifacts.

Engineering Design Skills

Learning Goals 3.1 Employ the engineering design process: define a problem, generate ideas, select a solution, test solution (s), evaluate solutions (s), and present results. 3.2 Recognize the engineering design process and be able to explain its steps.

In this section, we discuss only findings among adults. Engineering design skills are also discussed under the *Future Technology* section. We found children were much more likely to have developed understandings of this process in the exhibition. Adult respondents ranked finding new and interesting information on engineering design as lowest among the primary messages in the exhibition. Their ratings average 5.9 (*SD* = 2.4) *N* = 73). Among adults in in-depth interviews, many could give a fairly complete set of steps in engineering design. But most of these respondents had not used either of the *EDLs*. Parents playing *Group Manager* roles did not engage at the interactives with their children.

> ***I was actually, more so, kind of watching the kids doing the little, you know, some of the little experiments that -- that were there. And just kind of, you know, running through it. And so it was more watching the -- the younger folks. (STW2B_DI_040106_CO_1 tr)***

Both these respondents told us they had come to the exhibition with this understanding. When we asked they told us they had entered the exhibition with the knowledge.

> ***Just applying the science, you know, just, you know, learning, it's just, you know, being investigative, finding out, going through the trials and errors, you know. If you have this idea and you're trying to figure out how to -- how to -- how to make it work. So it's a lot of trial and error. (STW2B_DI_040106_CO_1 tr, p. 15, female)***

> ***Well, like you need to know your way of technology, like how to build things. And also you -- when -- if you get it wrong the first time, you keep on trying until you get it right. So it's like a building of character. (STW2B_DI_040106_CO_1 tr, p. 15, male)***

Future Technology

Learning Goals
You play a role in the future of technology**.** (Envision themselves as future scientists, engineers, workers, consumers and citizens in creating technologies of the future.)
Identify their own capability to design solutions to a problem.
Display excitement and enthusiasm for pursuing science and design activities in and out of school.

There were three learning goals in this area, all focused primarily on children. This data was collected during in-depth exit interviews. We asked children to draw a picture to tell us about what they did in the exhibition. The purpose of this method was twofold. First, we wanted to identify what aspects of the exhibition had been prominent to children of different ages and genders. Second, pictures are a comfortable way for many children to express themselves. We have found that being the audience for a child to explain a picture provides comfortable context for conversation. It allows children to know that the interviewer is interested in what they have to say. After children explained the pictures they had drawn, we asked them if they had seen anything in the exhibition that gave them ideas about jobs they might like to do when they grew up. This lead question was follow by probes to allow children to talk about their level of interest in job areas featured in the exhibition.

Excitement and Enthusiasm—What Attracted Children's Attention

We collected 35 drawings from children, 15 from girls and 20 from boys. The children's ages ranged from 3 to 16. Given the large size of the groups, we were not able to interview all children about their drawings. Two 3-year-olds did not want to talk with us and two teenagers wrote text information on the drawing template. Given this group of drawings, we found several themes. Nonetheless, we want to stress that this method had some limitations in assessing children's overall experience, particularly given the theme of this exhibition. It is hardly surprising that pictures of an exhibition about wars in space would feature a large number of weapons, severed hands, and heroes with light sabers. From interview data with children, we know that these were not the only things they saw in the exhibition, nor were they the only connections they made.

As we noted, several children drew characters with light sabers. There included depictions of Darth Vader, Darth Maul, Yoda, and simply light sabers themselves. In some cases, pictures drawn of these characters by younger children in the group appeared to be copies of older children's drawing. This is a pattern we have identified before in asking children to draw pictures in family groups. The older children's interests influenced the younger children's ideas about what is important and what to draw. This is one reason it is important to look at the child's drawing in the context of the group and in the context of their own explanation of the drawing.

In one example at MOS, we interviewed a large group of eight people, two families, who had come to the exhibition on a crowded Saturday. The four children in the group ranged from ages 1 to 10, one of whom had done two drawings. Four of the five pictures from this group included light sabers. However, as we spoke with the children, we learned that this was not all that they had seen or remembered.

One 5-year-old girl drew a picture with light sabers. Her older brothers also chose this topic. When we talked with her about what she had seen in the exhibition, she recalled a number of specific items that had captured her attention and interest.

> ***[I saw] Darth Vader. And robots. . . . They--we saw a little show about them. They were like moving. There's little like dogs robot. And it was like kicking a goal into the basket. (STW2B_DI_040106_CT_2_tr, p. 69, female, age 5)***

Her memory of the little dog robots refers to the soccer playing robots in *2.02 Robot Theater*. The light sabers were not her only memory, just the one she chose to draw.

We also talked with her older brother. As we talked with him, we also found that he had made a clear connection between another exhibit and a career.

> ***When I saw the--like the--the--like Landspeeder, I thought about like building like machines and stuff. (STW2B_DI_040106_CT_2_tr, p. 69, male, age 10)***

Of the four children with whom we talked, three had drawn pictures including weapons. Clearly this is a very memorable idea from the films, and although it was only one of many exhibit elements, it was a popular one. Figures 14, 15, and 16 show pictures of weapons. B Figures 14 and 15 also show the influence of an older sibling on a younger one (STW2B_DI_040106_CT_2). Figure 16 was collected as part of a in-depth interview at COSI *(STW2C_DI_071006_CO_10, male, age 13).* But in many of these interviews, we also found other connections to technologies.

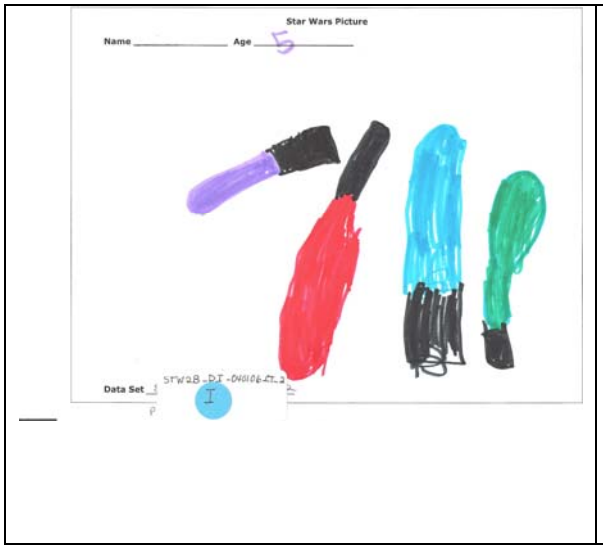

Figure 14.Younger Sister's Drawing of Light Sabers (female, age 5)

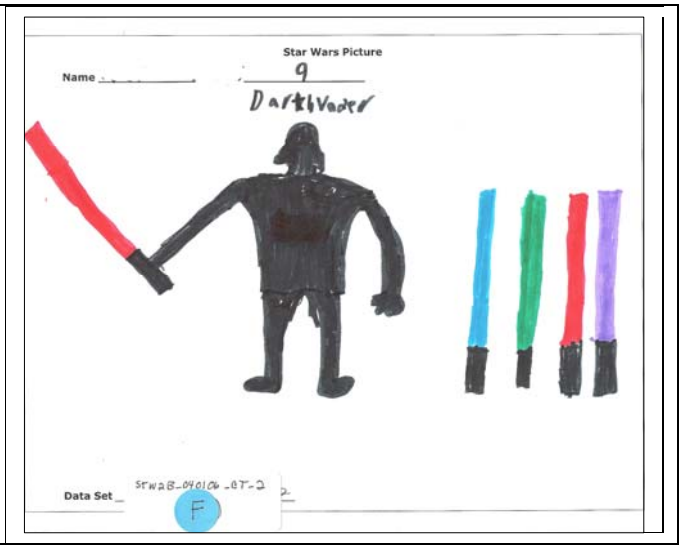

Figure 15. Older Brother's Drawing of Darth Vader and Light Sabers (male, age 9)

In another interview at MOS *(STW2B_DI_040106_CO_1),* all the members of the group expressed the highest level of satisfaction with the exhibition (a rating of a 10). The mother, her boyfriend, and the 11-year-old daughter all had a wonderful time. The mother focused almost exclusively on the *Star Wars* artifacts and had little interest in the technology connections. The adult man talked about the movie's connection to real-world technology. The daughter drew the picture of Luke's hand shown in Figure 17. At first glance, this appears to be primarily a film connection. But her explanation show connections to robotics and film technologies.

> ***Well, when I saw the hand--the--Luke's hand and Anakin's hand, I thought it was cool because we just saw the last episode just recently. And so it's so real, but when you look at it close it doesn't look so real. . . . That's a hole there. . . . I thought it was cool. I know it's kind of weird to have something that's just a hand of--a mechanical hand is cool. But I thought it was interesting how they back then [when they were first making the movies] they would use robotics like that. (STW2B_DI_040106_CO_1 tr, p. 23, female, age 11)***

When asked by the interviewer if she would like to find out more about the robotic hands, the respondent said she didn't know, perhaps she could look online. But then she added, quite unexpectedly making another connection to her experience, "But my class is getting to invent something." *(STW2B_DI_040106_CO_1 tr, p. 23, female, age 11)*

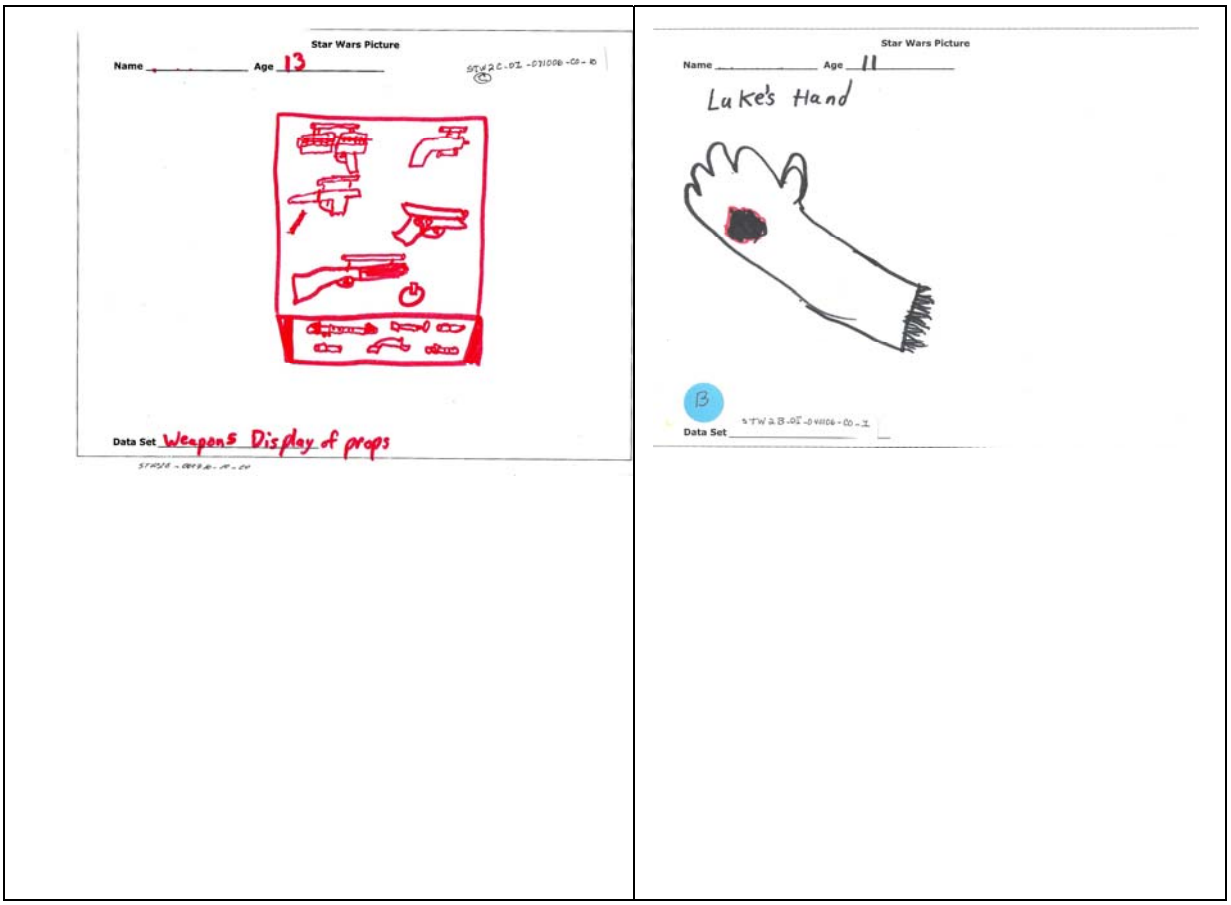

Figure 16. Drawing of 2.2, Weapons Display (male, age 13)

Figure 17. Luke's Hand (female, age 11)

Children also drew pictures of the several exhibits in the robotics theme area. These included the *2.12 Robot EDL, 2.05 B Dynamic Stability, 2.07A Walking Robot*, and several drawings that featured multiple robots and/or multiple exhibits. Figure 18 shows a drawing of *2.07 Walking Robot* and Figure 19 shows drawings of *2.12 Robot EDL* and *2.07 Walking Robot*. Both girls drew these as part of the same interview at COSI. All three children in this family made rich connections to the engineering design process and to career connections in the exhibition.

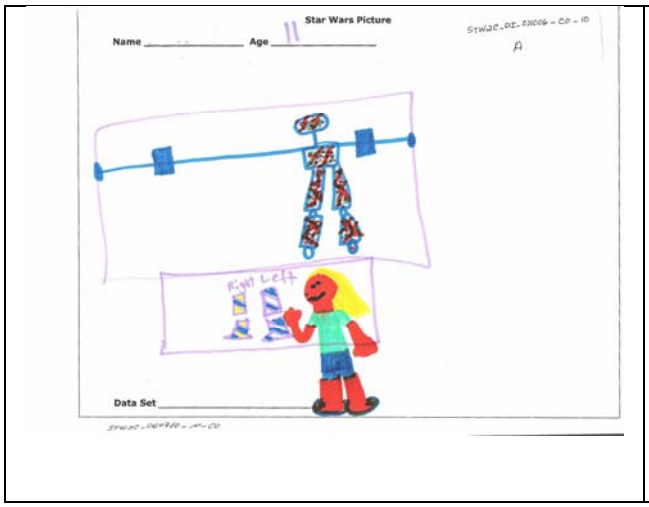

Figure 18. Drawing of 2.07 Walking Robot, (female, age 11)

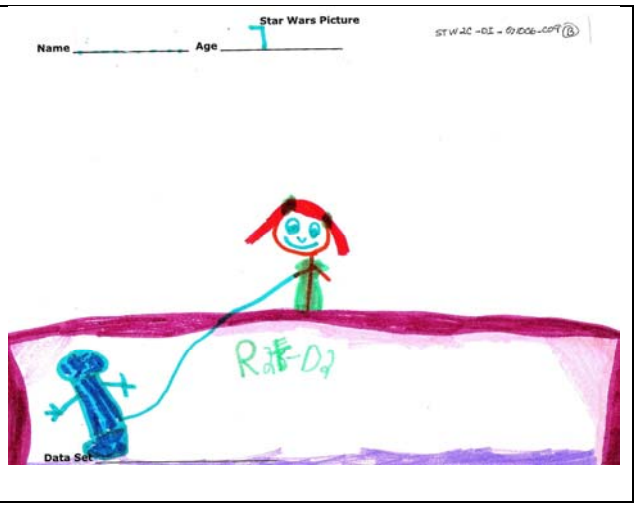

Figure 19. Drawing of 2.12 Robot EDL, (female, age 7)

We did not get a drawing description from the younger sister. The older sister explained what captured her interest in *2.07 Walking Robot.*

> ***And it's--it's really hard because you can't get--it's harder than it looks because you can't get--if you're not doing it right, and if you don't move a leg properly, then it will sometimes walk backwards. And you want to walk forwards. And when you're--when you're so close to--to the end you--you do something--something like slips or you do something wrong and then it just goes backwards and you're like, oh. Well, then you try again. And it's--it's a big accomplishment when you finish it. (STW2C_DI_071006_CO_9_tr, p.15 female, age 11)***

Despite the limitations of having children draw a picture, it had some clear benefits. A 5-year-old boy at MOS drew the picture in Figure 20. For a child this age he showed some clear understanding of programming and locomotion of the robot at *2.12 Robot EDL*. Perhaps an adult would not describe the process as sewing the wire into the robot's head, but he clearly got important ideas from this experience.

> ***You first had to make a robot and sew this wire in his head. And he (inaudible) if you wanted. And then he would unplug the wire and his hair was dry. And he would take it over to this place and then he'd plug a different wire into him. And then you make like the direction you want it to go in. And then it would float it into his head. And then you hit--you hit the go button. And then the wire and it goes--and they want it straight, turn it straight. (STW2B_DI_040206_CT_4_tr, p. 12, male, age 5)***

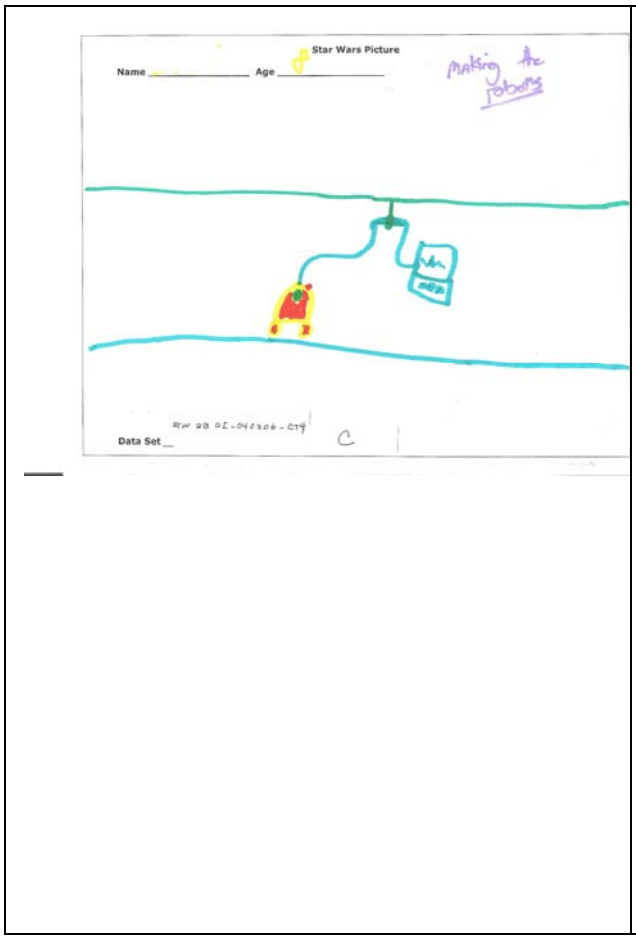

Figure 20. Drawing of the 2.12 the Robot EDL (male, age 5)

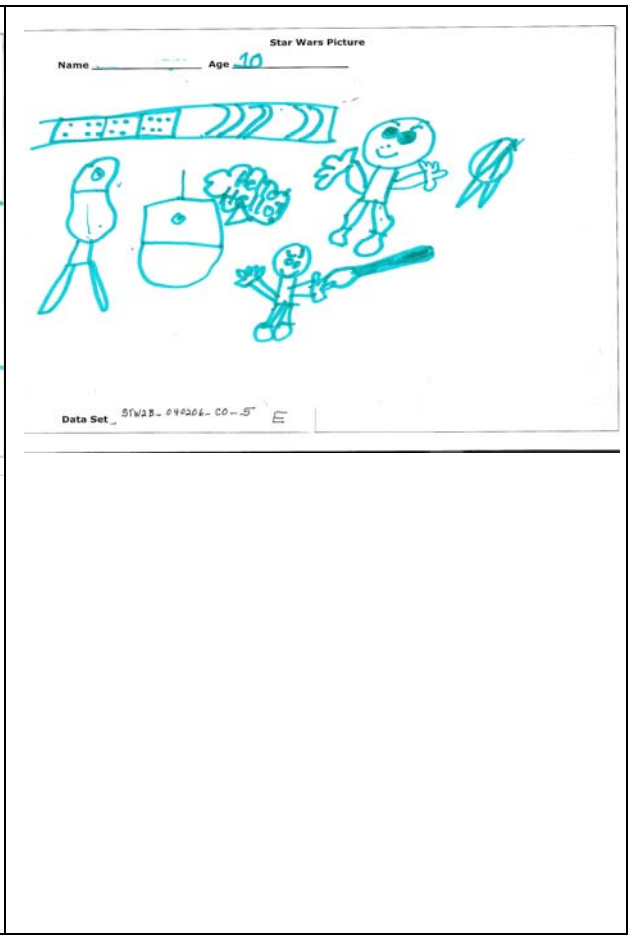

Figure 21. Drawings of Multiple Exhibits Including both EDLs and Various Characters (male, age 10)

Some children chose to include multiple favorite exhibit elements in their drawings. Figure 21 shows one of these drawings.

> ***Well, here is that Lego space thing. . . . And this is a ship on display like the Dark Star. . . . And a light saber. . . . And the R2D2 thing. . . . Storm troopers. Episode III and Episode II. . . . R2 and C3PO. (STW2B_DI_040306_CO_4_tr, 23-25, male, age 10)***

Children also drew pictures related to the transportation theme. The most popular object in this area was *1.01 Luke's Landspeeder*. Figure 22 shows one of these drawings.

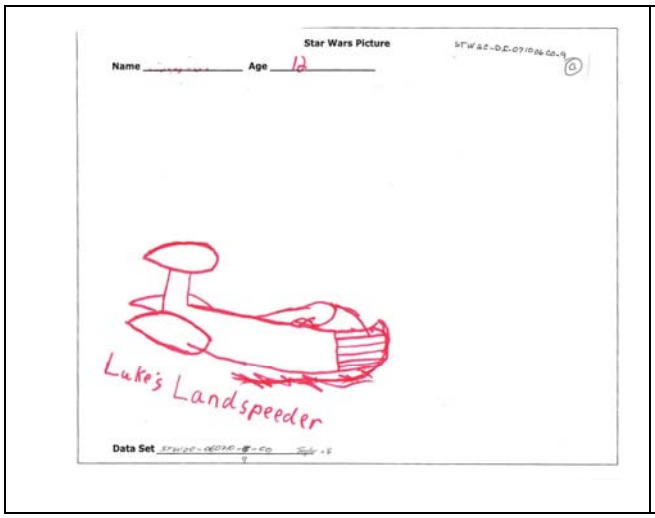

Figure 22. 1.01 Luke's Landspeeder (male, age 12)

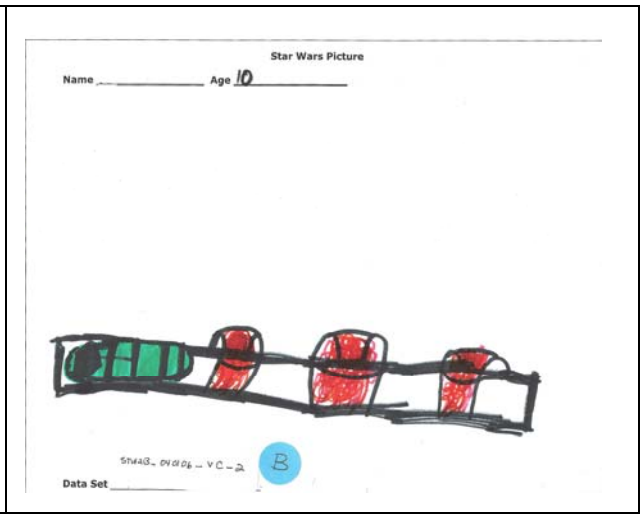

Figure 23. 1.08 Maglev EDL (male, age 10)

Two children specifically drew *1.09 Maglev EDL*. Several additional children described using this exhibit enthusiastically. We suspect it did not show up more frequently in pictures because it was difficult to draw.

> ***Well, this was kind of my favorite part, the Lego part. . . . And those are the magnets that it's put on. . . .and there was the coil that would push it. . . - And that's kind of the Lego thing that I drew . . . . The car thing. . . . I put [the magnet] in the middle. (STW2B_DI_040106_VC_2_tr, male, age 10)***

Children and Connections to Careers

Findings about children's connections to careers come from in-depth exit interviews. We explored the extent to which children made connections to careers in science, engineering, and technology. We asked them a series of three questions. First, we asked what they wanted to be when they grew up, and then we probed specifically for interest and connections to transportation and robotics technologies, sometimes asking them to rate their level of interest from 1 = *low* to 10 = *high*. We intended these ratings to provide a probe to help children express their level of interest and explain their reasons. We did not intend them to be averaged. We interviewed 10 groups with children under age 10 at MOS, and 12 groups of adults with children at COSI. In two of the MOS groups, we did not ask about career connections because of time and fatigue among children.

Job Focus

We found a few children focusing primarily on movie-making and acting exclusively. Younger children, who tended to focus more intently on the story and character elements of the exhibition, were somewhat more likely to make this connection. Yet these themes appeared among a few older children, too.

I could be [an actor] if they hired me for* Star Wars. *I could be a Jedi or Sith. . . . . I like swords. (STW2C_DI_070906_CO_6_tr, p. 23, male, age 5)

Back lots. I'd probably make movies, probably. (STW2C_DI_070906_CO_7_tr, p. 18, male, age 15)

Age Level of the Child

We identified three levels of developing maturity in career selection that appeared to affect the connections that children made to careers and the impact of technology on their future. Children in the middle age range appeared somewhat more likely to make new and exciting connections to what they had seen in the exhibition.

We interviewed some 5- and 6-year-olds who were still developing basic notions about the role of work in adult lives. One 5-year-old boy (STW2C_DI_070806_CO_1), when asked what he wanted to do when he grew up, responded "make ice cream" (STW2C_DI_070806_CO_1_tr, p. 26).

An interview with a father and his 5 ½-year-old twins provided insight into the level of maturity and how it can differ even at the same age. Like our other 5-year-old boy, the boy's idea of what it meant to be a grown up was just beginning to become clear. When the interviewer asked the boy if he saw anything in the exhibit about what he wanted to be when to be grew up, he responded with a somewhat puzzled expression:

I get to be a grown up I'll be a --I'll be a grown up. I'll be a adult. (STW2C_DI_070906_CT_4B_tr, p. 1, male, 5 ½ years old)

His father explained that "we don't spend a lot of time thinking about that." But his twin sister, who was the same age, told the interviewer that she had seen something in the exhibit connected to what she could be when she grew up. She said, "Being an actor." (STW2C_DI_070906_CT_4B_tr, p. 1, female, 5 ½ years old).

Slightly older children, ages about 7 to 11 years old, had a wider range of ideas about what they wanted to become. Many of these ideas did not appear to be deeply held, making them open to new ideas about jobs. In this group, we found the most numerous and greatest range of connections. Many of these connections were to science and engineering careers. Most of these children had older brothers and sisters in the visiting group. They were influenced by both the exhibit and the exhibit's influence on their siblings. Several additional examples of these types of connections are provided in the family influence section.

People could program robots. . . . So programming robots. And like one--like pro--robots that go online or something. (STW2B_DI_040106_VC_2_tr, p. 20, male, 11)

Among older children (ages ranging from about 12 to 16 years old), we found that children incorporated the exhibit experience into their own identity, interests, and ideas. Children appeared to be making connections between what they were good at and who they were. At this age level, some differences between girls' and boys' interests became apparent, with some

evidence of girls' identity forming around connections with non-science and technology fields. This is a well-researched characteristic for girls as they approach adolescence.

> ***Not--I'm not sure. . . . Not really because--I'm not really--I don't really like doing technology even though I thought I liked technology. But I don't really do it myself because I'm really--I'm not good with technology at all. But I thought--I'm not sure really. Because--I'm more of a--a dramatic person. (STW2B_DI_040106_CO_1 tr, p. 24, female, age 11)***

It appeared that boys were somewhat more likely to say they were interested in science. One 12-year-old boy said he was a "science person." When asked about designing technology, he rated it at a high level of interest and showed considerable understanding of the connections in the exhibition. He also made connections to the functions of technology in society. He explained his high interest rating of designing cars and planes.

> ***Because we could--because then I could like change the modern world of transportation. . . . . because then you can fly safer. . . . Yeah, I could like put a big old magnet on the ground and then use another magnet to shoot the small one up in the air. (STW2C_DI_070906_CO_6_tr, p. 25, male, age 12)***

Some of these older children made very clear connections to specific exhibits and offered their own ideas about how they would design things better. One girl who had used *2.07A Walking Robot* said that she made a connection between this exhibit and possible jobs. Among several of these older children we found the theme of making things better and helping people.

> ***The robots. . . . I would build better robots. . . . Because I have some simple ideas because they're getting way too into it. Like they had to do the simple machines stuff. Like with those rotator things---- that's attached to your leg and all that. They're like making it stand still in one spot and trying to move the knee part without like making it go up and down. (STW2C_DI_070906_CO_7_tr, 26, female, age 14)***

In another interview (STW2C_DI_071006_je_2), a boy said that currently he wanted to be an inventor. He had persuaded his grandfather to bring him to the exhibition. While his focus was already clear, he made rich connections in terms of his interest.

> ***The only career that I--I really seem interested to pursue is a--is a inventor. . . . There's a heck of a lot of technology in here [in the exhibition]. And if I ever want to invent anything, I need to know the basics first. . . . I [am interested in] neuro- control, spacecraft, anything of--that I can think of that probably will cost five billion dollars or more. . . . I'm pretty--I've probably exhausted all my ideas for the transportation. I know magnetic levitation can't go everywhere. . . . I was obsessed with robots. And I don't know how the obsession started, but then I took a look at what robots were really like. I--and I basically quit and went on to computers. So basically I'm going to wait until I or somebody else invents AI--and then I'll get interested--more interested in robots. (STW2C_DI_071006_je_2_tr, p. 20, male, age 12)***

Influence within the Family Group

Parents, other adults, and older siblings influenced the connections children made to what they had seen in the exhibition. In one interview (STW2C_DI_071006_CO_10), we identified evidence of all these types of influence—family identity, the influence of older siblings, and parent as role model. All these children in this group made rich connections to the technology themes and possible careers in the exhibition that were characteristic of their age level. The dad operated a small family business building frames and chasses for hotrods. The mother helped in the office. There were three children, two girls ages 12 and 9 and a 7-year-old son. The oldest daughter explained her career interests. At 12, she could talk about them clearly, and they were much more clearly formed than those of her younger siblings. When asked if she knew what she wanted to do when she grew up, she replied,

> ***Yes and no, I'm still kind of--there are a couple of different jobs I'd like to do, but I can't decide which one. . . . Paleontology. Like kind of work for National Geographic doing like documentary stuff. And maybe--maybe an astronaut, maybe. (STW2C_DI_071006_CO_10_tr, p. 16, female, age 12)***

When probed, she said that designing robots seemed like an interesting job, but she had some reservations.

> ***Well, how the robot things worked I thought was pretty interesting. . . . I don't know, they look like they're so complicated, all the wiring and just getting them to work, it looks like it--you'd have to redraw and build different--like thousands of different models to see which one works the best. (STW2C_DI_071006_CO_10_tr, p. 16, female, age 12)***

Her younger sister responded to the question about what she wanted to do when she grew up by referring to her older sister's response.

> ***I probably want to be an astronaut, too. (STW2C_DI_071006_CO_10_tr, p. 16, female, age 9)***

We interpret this to mean that she had not really thought about this and looked to her older sister as a model for ideas. But on further discussion, she explained some connections to careers in the exhibition, but ones quite closely related to her dad's business and also resources provided by the family at home.

> ***There would be so much new technology you could put into a car that--if you really wanted to. . . . I like building and designing things, using whatever I can normally find. Legos are mainly the big thing. (STW2C_DI_071006_CO_10_tr, p. 16, female, age 9)***

The youngest of the siblings, a boy, age 7, said he wanted to be a "NASCAR driver." He saw connections to building cars in the exhibition, but said he had little interest in building the car himself. "I figure I'd just get a team and build a car." He said that his main objective was to go

really fast. To do this he would need, "Like a motor. You need the gas--gas in your tank, and some stuff like that." (STW2C_DI_071006_CO_10_tr, p. 18, male, age 7)

While we found parents to have a strong influence, the exhibition experience appeared, in some cases, to overcome parental influence. We interviewed a family where the children were homeschooled. The father was a pastor and his wife schooled the children. The wife, like many of the older children, expressed her relationship to technology in terms of what type of person she was.

> ***I don't know. We're not--I'm--I'm not a real technological base person. I think it's very interesting. And so from a curiosity, experimental, I would love to study it. I would always love to study it. But as far as designing, thinking up new ideas, that's probably not one of my fortés. I would probably rather research and study it, than actually do it. (STW2C_DI_071006_CO_8_tr, p. 23, female)***

Her husband expressed similar sentiments.

> ***Well, I could say "ditto" to that. I mean for me it's--it's more for informational purposes. It's nice to know some of the things behind the scenes and some of the technology. But I'm--I don't think I'm wired for the sciences and all the computer stuff. You know, I'm a more people-person type of personality. (STW2C_DI_071006_CO_8_tr, p. 23-25, male)***

Their older daughter showed little interest and noted few connections to possible jobs for her in the exhibition.

> ***Don't know yet. [I'm interested in] writing. Fashion designing. Archeology, photography. Those are a couple things. . . . I'm not really interested in it [engineering and design]. (STW2C_DI_071006_CO_8_tr, female, age 16)***

But both her younger sister and brother identified possible jobs they might like to do that connected directly to the exhibition experience.

> ***Well, I like how you can like make different kind of robots and stuff. I think that would be cool to do. . . . [Movie making] that's my ultimate one. I like--I liked to make movies and stuff. (STW2C_DI_071006_CO_8_tr, female, age 11)***

> ***The floating like little chair type thing [hovercraft]. You sit in it and it goes around. . . . I just want to see like how they built it. And it's just kind of weird how they did that. . . . It's just kind of cool how they do the stuff. And I'd want to do that maybe, because the building and everything, you come and put some new technology and you know all about it. I think it would be fun. (STW2C_DI_071006_CO_8_tr, p. 23, male, age 13)***

The brother displayed some understanding of the engineering design process in expressing a reservation about technological design.

Because that's just a lot of building. And you have to program it and it's probably not going to work the first time you do it. And you do it over and over and over. And it could take a really, really, really, really long time. (STW2C_DI_071006_CO_8_tr, p. 23, male, age 13)

In other cases, we observed how a child's attitude could be substantially influenced by a parent's opinion. We saw directly how open children were to parental attitudes and statements. In this interview, the father had a substantial technology background. But his work experience had not been entirely positive. His comments also show how the reputations of fields of work can spread and influence attitudes among families and society.

I can't stand engineers. . . .They are very difficult to work with. And the benefits just do not outweigh the pain in dealing with those people. So, no. . . Way back in the day, I was a network engineer. And I can't explain to you the fun and the enjoyment and the fulfilledness I had working with routers and--and monitoring them and monitoring that work. Because I mean it's very, very wonderful. And I don't do that anymore since 2001, the IT crash. And I miss it. But it was a lot of fun troubleshooting and coming up with the results for--for issues. It was the best thing in the world and I loved it. For the time I was doing it. So I guess I shouldn't have said that I didn't want to work with engineers, but they are a difficult breed. (STW2B_DI_040206_VC_4_tr, p. 19-20, male)

His daughter, responding right after her father's recollection of his experience, began responding with somewhat low ratings about to her interest in doing science and engineering careers. At first she seemed very tentative in admitting she was interested and made connections to these areas. She had used the two *EDLs* with her father, and the *2.12 Robot EDL* was her favorite—and her father's too. She rated her interest in designing trains and cars at the low end of the scale. Then she explained, gradually becoming more positive in her tone, that robots seemed more appealing to her than cars and trains.

[Designing cars and trains] would be fun, but after you get to do it after like years and years you probably get fed up with it. . . . Designing robots is different than designing planes or cars. Robots you can like make it do anything that you want. Whereas cars they just--or planes they just--Up down, pull it backwards. Yeah. (STW2B_DI_040206_VC_4_tr, p. 19-20, female, age 11)

Older siblings often influenced younger children's connections and interests. We do not believe that this is a transient influence because we have had found this pattern in other studies on career development. Older brothers and sisters are role models in the process of being interested and identifying areas of interest. In one interview, two brothers (11 and 8 years old) each drew pictures of robots. When asked if he had seen any connections to jobs he might like, the older brother explained,

Actually, sort of build robots. . . .That could help like do things around house. Sort of like C3PO. Walk around, pick things up. . . . So like if it was hungry we would have the bolts in the garage, it would go out grab some. Or if it had loose one, it could go

out, grab one, and screw it back on. (STW2B_DI_040306_CO_5_tr, p. 25, male, age 11)

His younger brother indicated the same job interest, even directly connecting it to his brother's.

Same as him. . . . Well I would--I would build a robot. I would build it so like it would clean my room and stuff. Like a little sweeper. . . Like have its own little personality. (STW2B_DI_040306_CO_5_tr, p. 26, male, age 8)

In other families we could see a high level of overall family interest and value for science and technology. In one interview (STW2C_DI_071006_CO_9), all the children made deep and rich connections. In the interview, both parents displayed their own curiosity and understanding of the emphasis of the exhibition. The mother in this group said she taught organic chemistry at Wayne State University. The dad said he worked as a resource specialist for the US Army.

I mean Star Wars is science fiction but throughout this whole thing they're telling you that the basis for all this science fiction is something that is real or can be real. (STW2C_DI_071006_CO_9_tr, p. 11, female)

It's all--it really is engineering and science. And people don't realize that. People forget that. (STW2C_DI_071006_CO_9_tr, p. 12, male)

The children were similarly thoughtful and made rich connections between activities at home and in the exhibition.

I know I want to do something with engineering maybe. Invent a new technology and stuff. Because it always seemed cool to build stuff. I know we have a lot of Legos so we build a lot. (STW2C_DI_071006_CO_9_tr, p. 17, male, age 9)

This led to the discussion of a direct connection to his interests in *1.09 MagLev EDL*, and also identified the underlying scientific phenomena.

The Maglev trains can like levitate by magnetics they could put magnets in cars and on roads so then you can hover all around and go without friction and stuff. (STW2C_DI_071006_CO_9_tr, p. 17, male, twin 1, age 13)

His twin brother identified an interest in robot design and some of the goals for looking at their role in the future. His comments also show his understanding of technology's possible role in improving things for people.

I'm not sure at this moment [what I want to do]. But like previously from now I thought of making movies like George Lucas would. . . . But now I'm not really sure what I want. . . . Well I kind of liked the cybernetic arms and prosthetics for people. And it would be kind of cool if I could design those for a living to help people out. And since I have all my body limbs, it would be cool to help people who don't and give them closer to my life. (STW2C_DI_071006_CO_9_tr, p. 18, male, twin 2, age 13)

Their sister said that she wanted to be a doctor, and she made similar connections to helping people and connections to her established career goal.

> ***With prosthetics--doctors help other people who lost their limbs to get--to get a chance of doing things that they couldn't do without those limbs. (STW2C_DI_071006_CO_9_tr, p. 18, female, age 11)***

Agenda for the Visit
Based on all these interviews, there appeared to be some optimal level of intensity of the focus on the *Star Wars* films. Almost all groups expressed their interest in and liking for *Star Wars*. But we found one or two cases where the *Star Wars* film focus of this visit seemed to completely block the children from making rich connections to the scientific and technical aspects of the exhibition.

In one in-depth interview (STW2C_DI_071006_je_1), a father brought a group of children to the exhibition. These included his daughter, age 11; his son, age 11;and two of their same-sex friends. The female friend was 11 years old. The boy's friend was 15 years old. This visit had been prompted by the daughter's teacher who was described as a big *Star Wars* fan. Neither of the girls had made any connections to careers. Both of the boys said that they had but only talked about them at a very basic level. One said he might be interested in "building robots" (p. 20 male, age 15). The other said "making the costumes would be fun" (p. 20 male, age 11)

One mother explained, "We were mostly interested in the *Star Wars* connection" (STW2C_DI_070806_CT_1, p. 11). The interviewer asked her son if he made any connection to careers or jobs he might do when he grew up. He said "No." When probed directly about designing new technologies, he expressed a low level of interest and said,

> ***It might be probably easy to build a robot. (STW2C_DI_070806_CT_1_tr, p. 11, age 9)***

At the other end of the spectrum, we interviewed a large 15-member, three-generation group that had come to COSI primary to see the *Big Machines* exhibition (STW2C_DI_070806_CO_1). They only visited the *Star Wars* exhibition for about 15 minutes. The children in the group had rushed through to see the *Star Wars* characters. An 11-year-old boy appeared reluctant to answer, when probed said he had no interest being a scientist. A 7-year-old girl said she wanted to be a veterinarian, and the youngest, a 5-year-old boy, was our friend who wanted to "make ice cream" when he grew up. Not surprisingly the children made no connections between the exhibit experience and careers. This was due to a short length of stay; also, the visit to the exhibition was an add-on to another primary experience. By way of contrast, this interview confirms the impact of more extended exhibition engagement.

Summary of Findings on Children and Careers in Science and Technology
We found that many children made substantial connections between the exhibit experience and careers. In general, children made connections to two groups of careers and job possibilities. Most of the connections we heard were related to science and technology. We found a few children focusing primarily on movie-making and acting exclusively. Factors that supported these connections to science and technology careers were the age level of the child, the

influences within the family group, the agenda for the visit, and the level of crowding in the exhibition during their visit. To some extent these factors overlapped and worked together to support or detract from children making these connections. Younger children (5 to 6 years old) were still developing the concept of work as a part of an adult's life. They picked up few ideas about careers or jobs—they had not yet developed a framework in which to organize this information. Children in the middle age range (7 to 11 years old) appeared to absorb and make connections to the largest number of new ideas and possibilities about careers. These children had a framework for this information and were still very open about thinking about themselves in a variety of roles. Older children (12 to 16 years old) already had a more sophisticated framework about choosing a career based on identity, abilities, and activities they enjoyed. Their level of certainty about their choices varied. Yet these children were integrating career information into ideas about their own identity and other experiences related to the exhibit experience.

Summary of Outcomes and Impacts

In this section we discussed outcomes and impacts. We defined outcomes as short-term impacts of the exhibition, particularly those related to the learning goals and messages defined by the exhibition team. We defined impacts as evidence that people would carry with them knowledge, skills, and experiences gained in their experience and make connections to ongoing learning and other contexts such as additional museum visits, television programs, books or newspaper articles. For children, contexts also include formal education experiences and career plans. Informal learning environments are designed to provide highly engaging and satisfying experiences that motivate learning in these other areas of visitor lives. We will discuss the extent and nature of satisfaction respondents had with their *Star Wars* experience. We will also look at the extent to which they understood the Big Idea of the exhibition, and the extent to which they understood the primary messages and accomplished the learning goals.

In structured exit surveys we found consistently high satisfaction ratings across locations and groups. The overall satisfaction rating with 1 = *Low* and 4 = *High* was an average of 3.7. Respondents with higher levels of interest in and knowledge of science and technology rated their satisfaction even higher. But this relationship was at a moderate level. Most, but not all, people who went to the exhibition reported being highly satisfied.

In in-depth interviews we got a deeper understanding of what factors contributed to and detracted from satisfaction. Among most respondents, an important ingredient of their satisfaction was the *Star Wars* theme, and the excitement and intensity of attending a big exhibition with many other people. Costumes and artifacts contributed to satisfaction, along with the opportunity to share the occasion with family and friends. Both adults and children valued the opportunity to engage in interactives and learn about science and technology. The most important factor detracting from satisfaction was crowding.

For some respondents, more at COSI than MOS, there had been a hope and expectation of more *Star Wars* artifacts and less science and technology. We attributed this to the attractiveness of the exhibition of both *Star Wars Adventurers* and *Star Wars Epic Fans*. *Star Wars Adventurers* were more likely to make the connection between their own meaning orientation and the science and technology themes in the exhibition. *Star Wars Adventurers* were more likely to mention the differences between their expectation and the experience and still be quite satisfied. Adult *Star*

Wars Epic Fans who had expected a more artifacts-based experience focused on the characters and themes were the most likely to be less satisfied with their experiences. Very few respondents were dissatisfied.

Another factor that contributed to levels of satisfaction was crowding. On less crowded days all types of visitors appeared more satisfied. On crowded days, people in *adult only groups* adjusted to crowds by avoiding interactives and focusing on other aspects of the exhibition. Across all groups and social roles, people in adult groups appeared less intense about their initial expectations. They were less likely to express dissatisfaction with crowding. Among *groups with children under 18* satisfactions among adults was highly tied to social roles. Parents' satisfaction appeared to be affected by their own expectations and how they evaluated the enjoyment and learning opportunities for their children. The distance traveled appeared to intensify these factors.

Respondents interpreted question about *Big Idea* of the exhibition in two ways. First, "What do you think the designers of the exhibition intended you to get from the exhibition?" Second, "What did you intend to get out of coming to the exhibition?" The exhibit design teams defined their *Big Idea* for exhibition as "you can have fun using technology skills to design a future, like the *Star Wars* Universe." (Museum of Science, 2005A, p. 17) In the final analysis, we would estimate that more than half of the visitors to the exhibition understood the *Big Idea* of the exhibition, and others understood part of it. Our quantitative findings about the *Big Idea* of the exhibition do not provide a clear answer to the question "To what extent did visitors get the Big Idea of the exhibition?" We can say that only about 16.9% of the respondents to the exit survey appeared to make no connections to the science and technology content of the exhibition, about 40.3% made at least one content connection, 33.8% made at least two content connections, and 9.1% made three content connections.

In in-depth interviews, we found that some visitors clearly understood the intended *Big Idea* of the exhibition, but did not embrace it as their own. Particularly among adult *Star Wars Epic Fans*, respondents clearly understood the intended *Big Idea*. This was simply not why they came—it was not their *Big Idea*. This impacted how they engaged with the exhibition, and to some extent how satisfied they were. We also found some respondents who never fully comprehended the *Big Idea* of the exhibition. These visitors tended to come with clear expectations that the exhibition was about *Star Wars* artifacts. In other cases they expected the exhibition to be about *Star Wars* special effects or technology. These respondents never made the explicit connection between *Star Wars* technologies and real-world technologies. We identified more of these respondents at COSI, and we associated this with the focus of marketing materials on *Star Wars* characters and images. Another influence could have been the previous *Star War* exhibition focusing on special effects. But meaning orientation appeared to play a role. *Star Wars Epic Fans* tended to be more likely to misunderstand the *Big Idea* "having fun experiencing real *Star Wars* artifacts." *Star Wars Adventurers* tended to be more likely to grasp only the *Star Wars* technology part of the intended message. They understood the exhibition as "having fun exploring the technology in the *Star Wars* films and imagination required to produce them." Not fully grasping the Big Idea also appeared connected to the social role the person played in the visiting group. *Primary Visitors* appear much more likely to get it than *Group Managers*.

There were five primary messages and sets of learning goals focused on adults. In general we found respondents appeared to have the clearest understanding of the role of imagination and creativity in technology design. Second in overall strength was the idea that there are current, real-world technologies similar to those in the *Star Wars* films. At somewhat lower levels of understanding were the importance of knowing about scientific phenomena in technological design and the importance of understanding trade-offs in making decisions about new technologies. Lowest understanding of these five messages was about concepts in the engineering design process and the extent to which visitors felt empowered to actually give it a try. The strongest area of impact we found was related to real-world technologies. Even on crowded days, among *Star Wars Epic Fans* and among visitors working hard as *Group Mangers* and whose attention was not focused on their own experience, we found adults who had identified new technology that they thought they would explore further. This effect did not depend whether or not people fully grasped the *Big Idea* or whether they embraced it.

Among children understanding the role of imagination and creativity was also strong. But they were much more likely than adults to have both engaged in the engineering design process and have made clear connections to it. Based on age level, we found children who had engaged at either of the two *EDLs* had either reinforced their existing knowledge or made connections to the process as a whole and their experience. We also found numerous connections to both *Star Wars* and real-world technologies among children's pictures. But there was evidence that some children, particularly in younger ages groups, focused on the narrative elements of the experience. Even among groups in which parents had relatively little science and technology expertise, we found surprising numbers of connections to science and technology careers.

To synopsize these findings, we found the *Star Wars* exhibition produced overall high levels of satisfaction among all visiting groups. Factors that support levels of satisfaction were the pleasure visitors took in the *Star Wars* theme and artifacts. They also enjoyed being with family and friends at an exciting special event. Both adults and children valued the opportunity for children to engage with interactives and learn about science and technology. The biggest detractor from satisfaction was crowding. Also detracting from satisfaction were expectations some visitors had that the exhibition would be simply a display of artifacts from the films. While many respondents understood the *Big Idea* of the exhibit, some did not embrace it as their own. Others never understood or fully grasped the Big Idea, but there was still substantial impact related to one or more of the exhibition goals. Children, especially those older than seven, made age-appropriate connections to the imagination and creativity message. Many made exhibition-based connections to technologies, and many made connections between the exhibition experience and jobs and careers.

Accessibility

In this section we discuss findings related to the universal design goals of the exhibition. These are based on five in-depth interviews at MOS and four in-depth interviews at COSI. We interviewed people with disabilities along with their family, friends, and service providers in the context of the exhibition experience. We organized our findings around the specific design elements to support universal access that were part of the *Star Wars* exhibition at both locations. These included the multi-media tour (MMT) that featured video with American Sign Language

(ASL) interpretation of exhibit labels and other information included in the tour for all visitors. We also focused on audio descriptions provided at exhibition elements specifically intended for visitors who low vision or who were blind, but used by many other visitors. In addition, videos we discussed earlier which extended the holding time of several artifact cases also had open-captions.

We observed and talked to people about pathways, crowding, and lighting--aspects of particular importance for people with mobility impairments visiting in wheel chairs and people with visual impairments. Since people with disabilities, like older visitors and groups with young children, take more time to use exhibition elements, we asked our respondents about the adequacy of places to sit and rest during the exhibition experience.

Since interactives were an important part of the learning experience in this exhibition, we observed and used interactives with visitors. Artifact cases with models and costumes were another important element in the *Star Wars* experience. We observed and discussed accessibility of each of these types of exhibit elements. Respondents made us aware of the economic barriers to attending exhibitions and also made suggestions about how to spread the word about the availability of accessible experiences. Finally, respondents helped us understand the need for orientation to the spatial layout and connections between spatial and conceptual organization for people with disabilities. They also made us aware of how many of these design features could benefit all visitors.

Design Elements

MMT with ASL

One of the respondents we interviewed at MOS interpreted the ASL on his MMT as a sign of welcome. He explained in the interview that he found this information much easier to access since ASL, not English, was his first language. Both he and his wife pointed out words in labels that were difficult for him and stressed how very useful the ASL was in his visit. He explained that, while he did get information from and appreciated having, the closed captioning on videos, the ASL was simply much easier for him to understand. However, as we explained earlier, handling the device interfered with his communication. By the end of the visit, he had stopped using the MMT. We attributed this to the blocks in social engagement. He and his wife were both gregarious and highly communicative people. We found that the information from the MMT offered him a greater amount of information to share in social engagement with his wife. Instead of being dependent on her to provide information, he had this benefit in terms of social parity.

In contrast, a respondent at COSI, a male who was deaf, had a master's degree in biology and an extensive career working in science laboratories. He loved science. He was enthusiastic about the MMT. He and his friend both had versions of the multimedia tour. Both persisted in using them throughout the exhibition. Both read labels. The respondent who was deaf read them more extensively and with greater interest. He had higher levels of educational background and interest in the science and technology elements than his partner. He explained,

> ***I have good reading skills and a good background in reading. You have to remember, there are a lot of different levels of deaf people. That we're not all the same. . . . We're***

all individualized. And some can't read and sign. And maybe some don't understand the words and they'd rather have the signs. But for me, I did very well with both because I grew up in a hearing environment and I have deaf friends and I'm involved in the, you know, I kind of have that fishbowl of mixed of hearing and deaf. And I socialize with all of them. So I--I go--I mesh very well in both communities. But deaf--deaf people tend--sometimes tend to prefer a person rather than having a PDA as an interpreter. But you know, there's just different variations. (STW2C_ACC_070906_CT_B_tr, p. 7, male, deaf)

The MMT provided social advantages for a male respondent and his friend whom we interviewed at COSI. His friend explained they both could go through information and then discuss it. The respondent who was deaf explained,

I hate to be interrupted, you know, when I'm reading. I'd rather finish what I'm into and then ask the questions and discuss it later and then move on to the next exhibit. (STW2C_ACC_070906_CT_B_tr, p. 13, male, deaf)

This respondent was clearly very enthusiastic about the MMT with ASL.

The technology has changed, the PDAs, I'm fascinated with this. I can learn more with this. And this is really--the PDA has really helped me a lot--understand a lot better. Before I would look at the big screen and try to read everything. And people moving in front of me and they would interrupt me. And it just wasn't as good. So--and sometimes there was like glass examples. And people would be in front of it and I couldn't see so I just, you know, not bothering go around and see something else, some other display and forget about that. But with PDA I just, you know, here I saw almost everything. (STW2C_ACC_070906_CT_B_tr, p. 6, male, deaf)

At COSI, the two interpreters who accompanied the group recognized the individual signing on the MMT. Both were highly impressed by the quality of the ASL on the MMT and recommended that this video be adapted and distributed to ASL training programs. They said that this would be quite useful for practice for interpreters, and it would also spread the word about growing accessibility in museums.

Audio Descriptions at Exhibits

All respondents who used audio descriptions at exhibits (primarily respondents with low vision and those who were blind) valued them and they added to their experiences in the exhibition. These audio descriptions were provided by HearPhones, the brand name of a device which had a small speaker on a cord that a visitor could hold to his or her ear. This allows individuals to listen privately. Audio descriptions changed from MOS data collection to COSI. In the initial configuration at MOS, designers tried to provide two different versions of information of varying depth. At MOS, this had confused some respondents.

Well, as far as I know the round button was the start. And when the prompt told you to push the square button, it was to start explanation of the exhibit. But it sent you right back to the beginning. And told you to press the circle button, which is the start button. And so it was a continuous loop that I believe could be fixed. It should be getting right to the point rather than having to go through that hassle. (STW1_ACC_111205_CT_E, male, low vision)

At COSI, developers had replaced the two-button version with a one-button one. While there were still calls for some additional information, the one-button system appeared less confusing. One respondent explained how HearPhones made her more independent in using the exhibition and improved the experience for others in her group.

> ***Well, this was a--a great exhibit. Like I said it was--and usually if the boys went in and couldn't--weren't here, it was maybe my sister or just my mom, they would have read me everything. . . . That's what they did at Titanic. . . . We took my son and--last year. . . . [My son] read some of the things. He read--yeah, a lot of times he'll read things to me. But then he gets bored, "Mom, come on, you know, it's all the same." (STW2C_ACC_071006_JE_D_tr, p.16, female with low vision)***

Videos with Artifact Cases with Open Captioning

Both respondents with low vision and those who were deaf cited the video interviews as favorite and accessible aspects of the exhibition. One young man with low vision, who had grown up with *Star Wars* movies, reported that videos with their narrative of the movie technologies were a very important part of his exhibition experience.

> ***I really liked the things on the audio. What it had to say about some of the exhibits. I like the hover around car when I went on it. . . . I also enjoyed--what was that car called that--that Luke Skywalker rode in--in the first thing we went and saw? . . . . The Land Speeder. I love the Land Speeder. . . . To get to actually see it is wonderful. Again, the explanations of the Land Speeder, it was excellent. ((STW1_ACC_111205_CT_E, male, low vision)***

Another respondent with low vision at COSI also found the videos a favorite experience.

> ***I appreciated the audio, you know. And pushing the buttons and seeing the different things. It would have--it had the screen and sometimes it would just have different pictures there. Like the costumes--the costumes from the movies, then they would compare it with some of the costumes that actually are worn today. (STW2C_ACC_071006_JE_D_tr, p. 16 female with low vision)***

For a male respondent at COSI who was deaf, another *Star Wars* fan, the open-captioned videos were also important and highly valued. He pointed out that captioning, which had developed since he was a child, had made movies and information much more accessible to him. These exhibit elements with their multimodal characteristics are good examples of universal design that worked for people with various disabilities.

Numbering Systems

Both the MMT and the audio descriptions at exhibits had numbering systems at both locations. Between MOS data collection and COSI data collection, changes were made to place the MMT numbers (larger labels with an R2D2 symbol) and audio description numbers (small white plastic labels with Braille numbers to the left of each exhibit) nearer to each other and to use consistent numbering. While this did not entirely prevent the challenge of hunting for numbers, we found less difficulty in finding items at COSI than at MOS among our observations with respondents with low vision (STW2C_ACC_070906_je_C; STW2C_ACC_071006_je_D).

Pathways

At MOS we had concluded that the pathways through the area were open and fairly easy to maneuver. We identified the importance for respondents who were blind, those with low vision, those who used a wheelchair, and those with balance issues (STW1_ACC_110405_CT_B; STW1_ACC_110505_JE_C). At COSI, with the exception of a few areas near the hovercraft, we found even more space among exhibit elements and pathways generally more open. Our respondents at COSI included several respondents in wheelchairs (STW2C_ACC_070806_je_A; STW2C_ACC_070906_je_C). Two respondents saw the exhibition in large motorized wheelchairs weighing over 300 pounds.

> ***Easy access, enough space to maneuver . . . . And everything is very--oh, what am I trying to say--the words. As far as seeing everything, even being in the--the wheelchair, it's accessible to view everything, also. Nothing was--was hard to view. (STW2C_ACC_070806_JE_A_tr, p. 4, female using wheelchair)***

> ***The viewing of the exhibits is--I would say excellent, I mean for being in the chair. . . . But when you--when you got a hard chair like mine, which is kind of large . . . . you turn around, you're worried about running over people that, you know, might be behind you. . . . And it gets kind of crowded in there. And it concerns you about moving around because you don't want to run over somebody's foot because--I mean this chair--just by the chair itself is 341 pounds. (STW2C_ACC_070806_JE_A_tr, p. male, using a motorized wheel chair)***

A few areas in the layout exhibition space at both locations provided challenges for some respondents. At MOS a respondent (STW1_ACC_110505_JE_C) found it difficult to get her wheelchair in the narrow space between *1.05B Building Communities* and the back wall, particularly with other visitors standing and watching people use the computer interactives. She also had difficulties in the *Star Wars* medical area. Space was tight approaching *2.11B Human or Machine* and the display cases nearby were too tight for her to choose to enter and then try to turn around or exit the area. At COSI, the area near *1.08A Ride on a Cushion of Air* provided little space for wheelchairs to maneuver. The lines for the exhibit prevented any attempts at using the *1.09 B*, the chair that had been added to provide additional accessibility.

Lines lead to another factor in clear pathways, that is, the level of crowding in the exhibition. In addition to pathway space, another issue for people using wheelchairs was crowding. One respondent explained why she did not use one of the *EDLs*:

> ***I think it was hard trying to get around the people, and get in position, and get the headphones on, and actually get the whole thing. (STW2C_ACC_070906_JE_C_tr, p. 2, female using a wheelchair)***

Another respondent made a clear connection to space and crowding. Her comments are another example of the importance of social interaction in a museum visit.

> ***I was going to say, I felt space-wise it seemed fine. If there just wasn't such a big crowd of people. . . . Well, I--I really could not have wheeled without running into people if I hadn't been totally focused on what I was doing. And so as far as socializing I didn't--I couldn't. . . . You know I really had to pay attention all the time as to what I was***

doing because there--it--it was work to do it. (STW2C_ACC_070906_JE_C_tr, p. 10, female using a wheelchair)

Another comment focused on the COSI gift shop, which was included in the exhibition space at that location. This respondent provided a good reminder that, to visitors, areas managed by different departments in the institution are all perceived as part of their experience at that location.

I think--personally, I think it could have been a little spaced out, you know, larger. Maybe put it in a larger area. Because of the--because of the fear factor of running over somebody's feet because your, you know, it's--it's a crowded area. . . . And you're going in there--and especially when you got that little--the store area where the aisles were little--kind of dinky, really. . . . And I think you have--you barely can move around. And I got this pump on the back of this thing. So I'm always looking up to see who am I going to --back up into this exhibit, or hit this window, or glass thing, or whatever. (STW2C_ACC_070806_JE_A_tr, p. 13, male, using a motorized wheel chair)

Places to Sit

It took all our respondents with disabilities longer to use the exhibition than it did many other visitors. Fatigue set in, especially when people were having a wonderful time and wanted to stay longer. Respondents with low vision had to negotiate the space of the exhibition and use magnifiers. Respondents who were deaf watched the MMT, closed-captioning, and sometimes were so excited to have an accessible experience that they wanted to stay longer.

I would have appreciated a chair once in a while--or a little bench or something, just to sit down. (STW2C_ACC_071006_JE_D_tr, p.14, female with low vision)

People visiting with the respondents, including the friends, family, data collectors, care attendants, and interpreters were searching for places to sit in the second half of the exhibition at both MOS and COSI. One data collector pointed out the need for stools to move among various exhibit elements, not additional bench seating. Standing at videos and display cases became problematic and several people in groups resorted to sitting on the floor.

Two respondents specifically cited a quiet place to sit as a reason they like *2.02 Robot Theater*. This is an example of success in providing a broad range of exhibit types that meet the needs of diverse groups.

I--I liked the 14-minute sit down exhibit. Or you know, the robot thing. . . . Well, I--I wasn't having to try to maneuver--You know and I was able to just kind of watch what was happening and what was going on. Now, I also did like--and I think it kind of goes along with that. I did like the exhibits, not the hands-on things but the--I don't know how to, you know, but like the--the--the ones that were the spaceships and those things that you could look at. I thought they were very informative if I could get lined up and be in position to actually see them. (STW2C_ACC_070906_JE_C_tr, p. 3, female using a wheelchair)

Interactives

Interactives were particularly important to several of our disabled respondents at MOS (STW1_ACC_110405_CT/JE_A, STW1_ACC_110405_CT_B, STW1_ACC_110505_JE_C, and STW1_ACC_111205_CT_E). All but one mentioned an experience at an *EDL* as a highlight of their visit.

> ***The thing where we had to build the--the thing with the Legos. What was it--the car or something? . . . .Oh, that Maglev . . . That was good because you really--you got the hands on and you had to really think about why is this not working and what to do about it. (STW1_ACC_111205_CT_E, female with low vision)***

We did not find this to be the case at COSI, where respondents with disabilities, along with other adult respondents, identified these as activities for children.

> ***Well, you think about that it is for kids. You know, the displays because of COSI is so hands-on for kids. And but I think maybe if you had someone standing there kind of coaxing people. Because after we started it was kind of fun trying to figure it out and trying to get it to work. And--and so I don't know if that would help. (STW2C_ACC_070906_CT_B_tr. p. 12)***

> ***Right. And that was--yeah, the--yeah manipulating ones were definitely useless to me. . . .But that may be an age thing, I don't know. (STW2C_ACC_070906_JE_C_tr, p. 2 female)***

We attribute this difference in perception to levels of crowding at the *EDLs* at COSI. The improvements drew more visitors, but adults seemed to see children and assume these areas were for children.

Tactile Graphics

At MOS, a female respondent who was blind pointed out the lack of tactile graphics in the exhibition. This made things more difficult for her, especially when there was no audio.

> ***It was interesting. I enjoyed going through it. But I would hope there would have been more tactile stuff. STW1_ACC_110405_CT_2, tr. 4)***

She talked about two types of tactile graphics that would have been helpful to her, one of which was scale models or line drawings to help her understand displayed objects.

> ***Also so that you would get some sort of impression of--not exactly the size, but how it's shaped relative to itself. And if they tell you some of this on the cone things. They'll say, you know, it's twice as long as it is wide or something like that. But even if you had a very simple tactile representation it would--it would give you a clearer picture. (STW1_ACC_110405_CT_2, tr. 7)***

The other things she wanted were textured tactile graphics to help her understand the materials the costumes were made of and the textures. We found this perspective echoed among respondents at COSI, though perhaps not as clearly.

Whereas I think, you know, being able to go through the exhibit and touch the different types of things, you know, that were--I mean I realize that some of the things were authentic things that you were not able to. But couldn't they have some sort of a replica. . . . I guess I felt--I guess I felt separated from the things. That I couldn't really get close enough to them to be able to figure out [what they were]. . . . that were so many that were under glass that--and like I said, I realize they're authentic or whatever, but if they could have some sort of replicated thing where I could, for example, the costumes. If I wanted to be able to see the details on them. (STW2C_ACC_070906_JE_C_tr, p. 12, female with low vision)

Ticket and MMT Price

At MOS, three of our respondents mentioned that they might not have been able to attend the exhibition if they had not been invited for the study; the ticket price was too high. This discussion of financial accessibility of the exhibition and the MMT continued among interviews at COSI. Census reports on disability show that persons with disability are more likely to be unemployed and families with disabilities are more likely to have financial constraints due to decreased employment and medical costs (Waldrop & Stern 2003 pp. 10-11).

I wouldn't have--I wouldn't have on my own. I mean--it's--I don't know exactly how much the exhibit is, but from what I quickly glanced, I think it was relatively expensive. And being on a--someone in a wheelchair generally is on a fixed income. And no, I wouldn't have. (STW1_ACC_110505_JE_C)

I mean you got people making $50,000 and $75,000 a year or something like that, it's probably nothing to them, right. But I'm only on SSI. (STW2C_ACC_070806_JE_A_tr, p. 13, male, using a motorized wheel chair)

It's very expensive. . . . I mean it's rough for us. . . . For me and [my son], I'm on a fixed income. And--because I think it was like 30 dollars a ticket or something. I know it was extremely expensive for Titanic. And my sister had participated in an auction for a charity-- and bought--got tickets. (STW2C_ACC_071006_JE_D_tr, p. 18, female with low vision)

Respondents at both locations were enthusiastic about the MMT and said it made their experiences richer and more enjoyable. Yet, they had concerns about the cost. At both MOS and COSI, the MMT was free to people with disabilities. However, at COSI, this may not have been widely publicized.

My thing, you know, was basically if I'd have known ahead of time--to plan for it. But for it to be sprung on you, like oh we have these extra incentives to help you understand for $5.00, But that was my only kick, not knowing. (STW2C_ACC_070806_JE_A_tr, p. 4, female using wheelchair)

You have to rent them, it's an extra cost. That's the problem. You know, a lot of deaf people can't afford to, you know, rent the, you know, they might think it's too expensive or--I don't know how much it costs. . . . But also when you buy tickets for two, does that include the PDA or is it a separate cost? STW2C_ACC_070906_CT_B_tr, p. 18, male, deaf)

Visibility

Overall, we found the higher level of ambient light in the exhibition as a whole very helpful to respondents with low vision and those using wheelchairs. One respondent at COSI explained that the lighting in *2.02 Robot Theater* made this a favorite experience.

Actually I was really going to say the robot thing--the robot movie thing also just because of the fact, to me I felt that even though it was dark, especially--you know, when they had the spotlight on each certain thing, that was a lot easier for me to see. And it was being, you know, I was able to listen and describe--you know, when it was describing--or you know when it was telling exactly what was going on. (STW2C_ACC_070906_JE_C_tr, p. 4, female with low vision)

At COSI, two of our respondents used 4X magnifiers in the exhibition. For them, point size on labels was not large enough.

I would make them--the labels a little larger. If you couldn't do it for all of the content, then I would go ahead and suggest that you have just the main heading larger with possibly different type of font. It would be slightly easier to read. (STW2C_ACC_071006_JE_D_tr, p. 2)

Another aspect of visibility related to crowding. When other visitors stood in front of labels or videos, the labels were not visible to respondents using wheelchairs.

And a variety of--of things that, you know, if you look through the white cone things, sometimes they had the TV things, the video is going on, and I think that by--there weren't a lot of people around there. I could get in front and see those and listen to what the video was saying. (STW2C_ACC_071006_JE_D_tr, p. 6, female with low vision)

Orientation to the Layout and Contents of the Exhibition as a Whole

At both locations we heard comments that called for information for some type of spatial and conceptual overview of the exhibition as a whole. We found that respondents with disabilities were very active problem-solvers and used available resources to negotiate space and ideas. Yet, they sometimes need to plan carefully how to negotiate both space and information. There were various recommendations—guided tours by staff members, print guides, and computers being the most popular. Spatial orientation appeared particularly important for those with visual disabilities and physical disabilities. Conceptual orientation appeared very important for respondents who were deaf and those with visual disabilities. As we noted in the section on pathways, this exhibition has no prime pathway. It is, however, spatially and conceptually, divided into theme areas. This relationship provides the opportunity for this type of orientation. But, at least to some respondents it was not entirely clear. Here are two of these comments that we interpreted in this manner:

Well and I was going to suggest, I mean, and not--not to segregate people, but my suggestion would be--because I would think that they would do this with like school kids and whatever. But like you were saying, have almost like an actual guided tour where somebody would present everything to you, you know, like a--like a group thing. You know, you would come like a group thing. You know, whether they advertised it or posted it somewhere so that people would know, okay at this time on this day of the week or whatever, if you have and want to come but you have disabilities or, you know, whatever. (STW2C_ACC_070906_JE_C_tr, p. 7, female using a wheelchair)

But with that amount of people or not I would think that if there were some type of a pattern to it and some type of a guide, I think that would have been helpful to everybody. And I can't imagine, I mean the people that were there with their kids and again strollers and--and/or not strollers, just trying to hold on to everybody. You're trying to take in so much and figure out where you're going. I think it's--I think that's a lot to ask. (STW2C_ACC_070906_JE_C_tr, p. 7, female

Impact of Accessibility on All Visitors

Several of the areas that improved the experience for respondents with disabilities were also cited by other respondents. In addition, areas that could be improved would also benefit other visitors.

Changes were made to the placement of MMT numbering and HearPhone system between our data collection at MOS and COSI. These changes clearly benefited all visitors. We heard many comments about looking for numbers for both systems at MOS, and fewer at COSI. In addition, we found that some people, particularly older visitors highly focused on artifacts, used the HearPhone systems. Two respondents from our in-depth exit interview cited the MMT with video as their favorite part of the exhibit (STW2B_DI_040208_VC_5). These same two men, in their sixties, also told us they enjoyed the HearPhones and used them at several locations.

The wider, more open pathways at COSI also benefited people visiting with children. At COSI, visitors could bring strollers into the exhibition. MOS did not allow strollers in the exhibition space. We heard three specific comments on this issue from mothers at MOS. But, as we discussed previously, the levels of crowding that affected our respondents in wheelchairs also affected other visitors.

We believe that the overall higher levels of ambient light at COSI also had benefits for other groups of visitors. In the darker gallery at MOS, our data collection team was approached several times by parents who had lost their small children. We had none of these reports at COSI where it was much easier to see from area to area within the exhibition space.

While the exhibition had some benches at both locations, clearly additional places to sit would benefit parents with small children and babies waiting for the rest of their groups outside an area. In addition, this exhibition drew substantial numbers of older visitors at both locations who

might benefit from additional places to sit. But we observed all visitors using the moveable stools available to sit and watch longer video segments explaining *Star Wars* film production.

We also believe that some of the improvements we suggested would benefit all visitors. All adults, not just those with disabilities, were more likely to use interactives when levels of crowding were low. The addition of tactile graphics, especially, in an exhibition with models, costumes and props would be a welcome addition to allow children and adult to look and feel the textures and shape of some of the artifacts in the cases.

Finally, in our demographics section we noted that most of the respondents to *Star Wars* were from relatively high-income families. Only one of our in-depth interviews featured a family that was very concerned about the cost of the experience. While we understand the economic reality of museum revenue streams, providing some option, perhaps for groups at times of low visitation could be considered to reduce the economic barriers to visitation.

Summary of Accessibility Findings

Many respondents with disabilities had experiences and outcomes similar to other respondents. In addition, many of their comments and perceptions helped us better understand the experiences and engagement of all respondents during the study. For example, our understanding of adult reluctance to use interactives came most clearly from one of the interviews with people with disabilities. One of the universal design principles is mutual benefit. We found the accessibility observations and interviews with individuals with disabilities also played this role in the evaluation study—helping us see and understand things that we might have missed without these perspectives.

But the experience of the respondents with disabilities also had some very specific challenges. We learned that visiting exhibitions—like going to the movies, shopping, and transportation—requires hard work and effort for many people with disabilities. This is hard physical work, mental work, social work, and sometimes emotional work. All the respondents with disabilities we interviewed were problem-solvers. We found that this made them very articulate in providing information about what did and did not work for them in the exhibition. Our respondents reminded us that all people with disabilities are different. Grand generalizations break down even about one group of people. Most of all, we want to stress that all the universal design features in this exhibition worked. They improved the experience to a great degree. In our own enthusiasm to identify what would make it even better, readers should not miss the great positive impact that universal design had on the experiences of the people we observed at both MOS and COSI. While this is a summative report, accessibility is a remedial issue in the field. The endeavor has started, supported by ongoing and sustained efforts like those at MOS. However, we find there is much to learn and many more accessible practices to prototype and implement. This should not reflect on the high quality of the work and efforts implemented thus far.

We found that, overall, the included universal design features appeared to increase the enjoyment and learning from the exhibition for most respondents. The exhibition worked best for people who were deaf and those who use wheelchairs. Respondents with low vision and those who were blind had the greatest challenges. We also found that the exhibition worked somewhat better at COSI than at MOS, due to higher overall light levels and more space between exhibit elements. In addition, the revised audio systems at COSI were easier to find and less confusing. We found

that at both locations financial accessibility was an issue for people with disabilities. We believe that this concern deserves consideration by institutions, funders, and other interested parties. Overall, we found the accessibility efforts in the *Star Wars* exhibition highly effective in increasing accessibility.

CONCLUSIONS

In conclusion, we will provide some overall statements about the effectiveness of the *Star Wars* exhibition. We will also make connections to the findings in this study to the larger world of informal science education practice.

Two popular culture terms best describe what we learned about the overall effectiveness of the *Star Wars* exhibition, state-*of-the-art* and *pushing-the-envelope*. *State-of-the-art* encapsulates the success of the exhibition in providing a highly satisfying experience for many visitors. It also captures well the success in providing many rich informal learning experiences with evidence that many visitors accomplish goals. We also found evidence of potential impact beyond the visiting experience. *State-of-the-art* also describes how the exhibition was created. At its inception the exhibition was connected to important national issues in technology literacy. Based on the field's success in making learning fun and relevant, a popular theme was selected to attract new and infrequent visitors to informal science learning institutions. Front-end analysis and evaluation was conducted to understand what visitors found attractive and relevant. The design team developed an explicit learning rationale based on theory with clear strategies, well stated goals, and clear messages. Types of exhibit experiences were carefully considered based on previous research and evaluation and best practices.

Pushing-the-envelope describes taking on a complex process such as engineering design and carefully designing and prototyping multi-station areas. The exhibition design team accepted a challenge and a risk in embedding experiences that are intended to prompt deep intellectual and physical engagement over an extended period of time into a theme-based experience. At this point in time, this exhibition is highly effective, *state-of-the-art*, and *pushing-the-envelope* in what can be accomplished in engaging exhibits. Among respondents who had access to this experience, primarily children and a few adults had clear connections to engineering and age-appropriate articulations of the process. The *EDLs* pushed the envelope and the challenge was largely met. Another way the exhibition pushes the envelope is by using universal design features to make the experience more accessible to people with disabilities. Using these two overarching measure and based on the findings of this study *Star Wars: Where Science Meets the Imagination* is a highly successful exhibition. To a great extent and for many people the exhibition accomplished many of the intended outcomes and impacts.

These two terms also encapsulate the exhibition's limitations. In this study, the experience in *Star Wars* was state-of-the-art in that, like other popular exhibitions, its capacity to attract visitors and the crowding that resulted, at times overwhelmed the capacity for satisfying learning This strong attraction level accomplished the goal of attracting new and infrequent visitors. Sometimes, these visitors are the people least equipped to select less crowded days to attend and lack confidence in their own abilities to guide their children's learning experiences. In other cases, adult visitors decided to come and found themselves overwhelmed by children visitors. But, we also identified some innovative and highly successful visitor services practices that provided at least some amelioration of the satisfaction issues.

The exhibition is also state-of-the-art in terms of the limited range of the audience it attracts and serves. Despite many ongoing efforts, many science museums still reach only the relatively well-

educated and high income households. Over the past decades many museums have become fee-based institutions and those fees have increased. As Hood's (1983) ground-breaking work on reasons people visit museums pointed out, the best predictor of adult museum-going is having attended museums with the family as a during childhood. Science museums may not be building an audience for tomorrow. We concluded that the demographics of the *Star Wars* audience were largely influenced by the ticket price. Interviews with people with disabilities provided evidence that ticket prices are a barrier to this group. We concluded that this was also the best explanation why there was not more economic and ethnic diversity among the audience.

Ticket fees are not simply issues for science and technology institutions. Underlying economic conditions dictate revenue streams to pay for the cost of innovative and rich learning experiences. Even with substantial outside support for development, hosting a large special exhibition such as *Star Wars* requires substantial investment in marketing, staffing, security, exhibition maintenance, and visitor services. Currently, the economic system supporting informal science learning has some implicit barriers for greater impact. But, efforts such as the universal design feature in this exhibition build a base for reaching out to more and more people.

Providing opportunities for learning and enjoyment within the same time and space for both adults and children is a major challenge. We found clear evidence that adults prioritized children's enjoyment and learning. Protecting and caring for children is a positive social value, but it reduces the opportunity for adults to engage with primary content. Parents, even those with rich science and technology backgrounds and expertise in guiding their children's learning, miss the *Big Ideas* and have less engagement with learning opportunities than do children. This is not to underrate the satisfaction parents take from their children's enjoyment and learning, but adults also can gain from these experiences. The field needs to continue to find ways to serve both audiences.

The *Star Wars* exhibition team used state-of-the art learning theory and findings to shape the design. The conceptual tools designers used included messages and learning goals. These are useful tools and only institutions with the expertise and vision of MOS employ them in such coherent and thoughtful ways. Findings related to visitor engagement, outcome and impacts testify to the power of these tools. They also testify to their limitations. The concept of messages is the application of communications theory. In practice the concept tends to become focused on the message senders, their meaning, and their goals. Disconnects are sometimes assessed in terms of the accuracy and level at which the message was received. Clearly, for some visitors, particularly adults whose attention was focused on children, this appears the most likely explanation why some did not understand the Big Idea of the exhibition. On the other hand, our findings about the differences in meaning orientation of some respondents show the limitations of these concepts. Some people understand but ignore the intentions of designers. They have their agendas and make their own meanings. In our assessment we did not find this substantially impacted visitor learning. It is a good thing for us evaluators to explore in front-end studies to alert exhibition designers to these issues. Many exhibition designers are creative people who will find a way to address this issue more thoroughly.

Finally, the efforts to attract visitors to the exhibition were state-of-the art. We heard from visitors numerous mentions of media sources including television, radio, newspapers, websites,

and travel magazines. The distances respondents traveled indicated the broad reach of these methods, and the crowds proved their effectiveness. But we did find some disconnect between the expectations of the respondents and the experience they found. Sometimes the most powerful messages to attract people to an exhibition may not produce the highest level of satisfaction and learning. Educational and marketing messages have the potential to be part of the same process. Marketing messages provide the advance organizers for exciting learning experiences. Highly satisfying educational experiences, based on clear but high expectations, provide good word-of-mouth, one of the most effective forms of marketing. To a large degree, the marketing and educational messages worked together in this way. But, the degree of disconnect between educational and marketing messages may have affected visitor satisfaction and engagement, particularly among some infrequent and new visitors. This is an important area that deserves further study.

In summary, given what we know about informal science learning and the tools we have, *Star Wars* was a highly successful exhibition. As it was intended to do, it attracted large numbers of visitors, many of which were infrequent and new visitors. Most visitors, adults and children, were highly satisfied with their experience. Not all respondent groups experienced all desired outcomes, but many adults appeared to make a clear connection to creativity and technological design and identified new technologies they might explore through addition museum visits, television programs, or by taking a class. Children made strong connections to the creativity in technological design message. Many, particularly those children above seven years old, made connections to real-world technologies and possible careers. The exhibition design team and other museum staff members accomplished this using state-of-the-art informal science research and practices. The goals addressed important national issues in technology literacy. The exhibition pushed the envelope with the development of the engineering design labs and other interactives to take on the challenging goal of helping visitors develop deeper understanding of the engineering design process. As the informal science education field progresses, learning from important exhibitions such as this will further our understanding of how and ability to create enjoyable and meaningful informal learning experiences.

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APPENDIX A: TOPICAL FRAMEWORK

Star Wars: Where Science Meets Imagination
Summative Evaluation
Topical Framework
June 30, 2006

Overarching Questions

1. To what extent and in what ways did the exhibition prompt visitation among different target audiences?
2. To what extent and in what ways do visitors with a range of characteristics (including people with disabilities) engage with the exhibition?
3. To what extent and in what ways did the experience impact visitors' knowledge, attitudes, and skills?

Attraction Level of the Exhibition

1. To what extent did the exhibition prompt a visit among different visiting groups? (new visitors, infrequent visitors, families, adults, people with disabilities, *Star Wars* fans)
2. To what extent did the exhibition experience encourage future visitation?

Engagement with the Exhibition as a Whole

1. How long did visitors spent in the exhibition? Are there differences among target audiences and demographic groups? (*Star Wars* fans, family groups with children of different ages, adult groups, groups including people with disabilities)
2. What were the attraction levels (where they stopped) of exhibits and cart activities in the exhibition? Were there differences in attraction associated with pathways (placement of the exhibit in the context of the exhibit as a whole)? Media type? Level of interactivity? *Star Wars* or real-world focus?
3. Where there differences in holding levels (time of engagement) among the various exhibits and cart activities? Were there differences in attraction associated with pathways (placement of the exhibit in the context of the exhibit as a whole)? Media type? Level of interactivity? *Star Wars* or real-world focus?
4. To what extent and in what ways did visitors interact with staff? Were interactions with educational interpreters or security guards? Did the nature and type of interaction suggest visitors had difficulty interacting with any of the interactives? Were these interactions supportive of good visitor experience--in what ways and to what extent?
5. To what extent and in what ways did using the MMT affect visitor experience? Where they stopped? How long they stopped?
6. To what extent and in what ways were people with disabilities able to fully in engage in the exhibit experience?
7. To what extent and in what ways were the universal design principals and adaptive devices used by people with disabilities? Used by all visitors?
8. What pathways did visitors take through the exhibition? What areas, exhibit components, and interpretation carts components did they use? How long did they spend? Were some areas of the exhibition less frequently visited than others? Some exhibit components?

What obstacles may have influenced this? Are there differences among target audiences and demographic groups?

9. To what extent and in what ways was the visitor experience affected by the levels of crowding and wait time for experiences? Was crowding a particular problem in any specific areas or at any specific exhibit components? What were differences in engagement and attitude at MOS where the *Millennium Falcon* was ticketed separately and at COSI where it was included in the exhibition gallery?
10. How were visitor experiences impacted by the presence or absence of seating? Were seating areas adequate and accessible? Did seating contribute to satisfaction?
11. How did groups of different size and composition negotiate the exhibition?
12. To what extent and in what ways were visitors with varying levels of *understanding and attitudes toward technological development* able to successfully engage with the exhibition?
13. To what extent and in what ways were visitors with varying levels of *understanding of scientific phenomena* able to successfully engage with the exhibition?

Outcomes

1. To what extent and in what ways are visitors satisfied with their experience in the exhibition? What elements are particularly satisfying? What elements detract from their satisfaction?
    a. In what ways and to what extent did the size of the exhibition effect visitors' satisfaction with the experience? Did they feel overwhelmed and dissatisfied? Did they feel overwhelmed or satisfied by the range of opportunity offered?
    b. In what ways and to what extend did the level of interactivity affect visitors' satisfaction with the exhibit? Were visitors with previous experience with more artifact-based special exhibitions satisfied or dissatisfied? Was the level of interactivity connected to problems with crowd flow or line wait times? Was the level of interactivity perceived positively or negatively among different visiting groups?

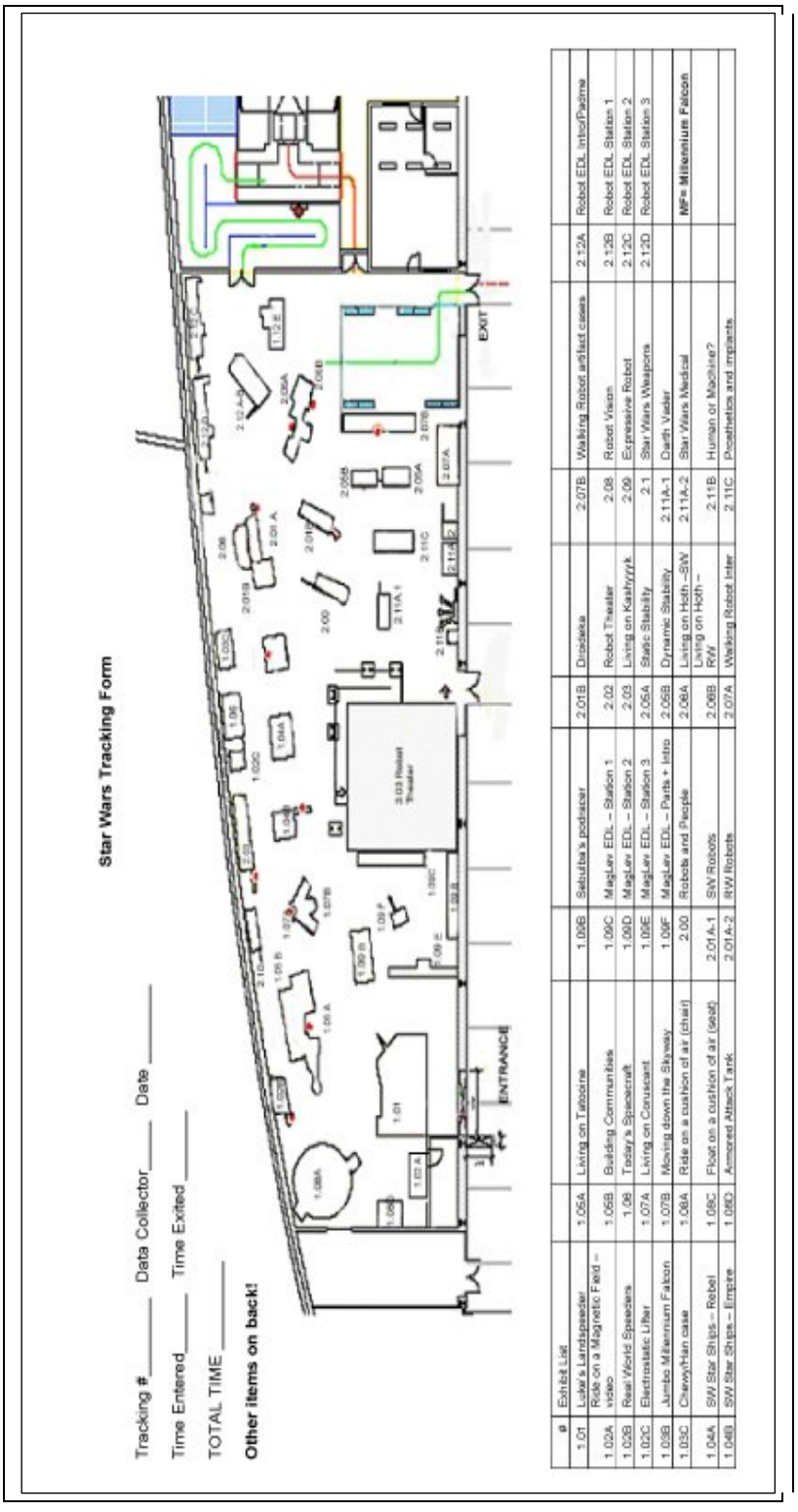
2. In what ways and to what extent did visitors feel empowered to try to solve the problems presented in the exhibits?
    a. In what ways did visitors understand and engage in experimentation as a common of process in science used to solve technological problems?
    b. In ways and to what extent do visitors understand the role that creativity plays in technological innovations?
    c. To what extent did visitors understand and engage in the engineering design process--defining problems, generating ideas, selecting solutions, testing solutions, and presenting results?

3. In what ways do and to what extent do visitors examine trade-offs of using a product or system and deciding when it could be used?

Impacts

1. To what extent and do visitors, especially adults, remember topics and processes of research on real-world technologies they saw in the exhibit?
2. Do visitors understand the real-world technologies in the exhibit as counterparts of the movie technologies? If so, is this connection associated with excitement, satisfaction, and motivation to learn more about the real-world technologies? Do they plan to follow this current research and learn more about it?
3. To what extent do visitors understand their decisions about new technologies in the context of the exhibit as involving weighing the trade-offs between the positive and negative effects on individuals and the society as a whole? To what extent to they generalize this type of decision-making to technology decisions in their own lives and in society?

APPENDIX B: TRACKING & TIMING INSTRUMENT



Star Wars Tracking Form

Tracking #_____ Data Collector_____ Date _____

Time Entered_____ Time Exited _____

TOTAL TIME_____

Other items on back!

#	Exhibit List		Living on Tatooine		Sebulba's podracer		Droideka		Walking Robot artifact cases		Robot EDL InfoPavilion
1.01	Luke's Landspeeder	1.05A	Living on Tatooine	1.09B	Sebulba's podracer	2.01B	Droideka	2.07B	Walking Robot artifact cases	2.12A	Robot EDL InfoPavilion
1.02A	Ride on a Magnetic Field – video	1.05B	Building Communities	1.09C	MagLev EDL – Station 1	2.02	Robot Theater	2.08	Robot Vision	2.12B	Robot EDL Station 1
1.02B	Real World Spaceians	1.06	Today's Spacecraft	1.09D	MagLev EDL – Station 2	2.03	Living on Kashyyyk	2.09	Expressive Robot	2.12C	Robot EDL Station 2
1.02C	Electrostatic Lifter	1.07A	Living on Coruscant	1.09E	MagLev EDL – Station 3	2.05A	Static Stability	2.1	Star Wars Weapons	2.12D	Robot EDL Station 3
1.03B	Jumbo Millennium Falcon	1.07B	Moving down the Skyway	1.09F	MagLev EDL – Parts + Intro	2.05B	Dynamic Stability	2.11A-1	Darth Vader		
1.03C	Chewy/Han case	1.08A	Ride on a cushion of air (chair)	2.00	Robots and People	2.08A	Living on Hoth –SW	2.11A-2	Star Wars Medical		MF= Millennium Falcon
1.04A	SW Star Ships – Rebel	1.08C	Float on a cushion of air (seat)	2.01A-1	SW Robots	2.08B	Living on Hoth – RW	2.11B	Human or Machine?		
1.04B	SW Star Ships – Empire	1.08D	Armored Attack Tank	2.01A-2	RW Robots	2.07A	Walking Robot Inter	2.11C	Prosthetics and implants		

APPENDIX C: STRUCTURED EXIT SURVEY SCRIPT

This is a script. It is NOT to be filled out by visitors. It is your tool to help YOU ask consistent questions and record responses. Use ONLY supplied options to record responses--other responses are not usable.

Tracking #	
Data Collector	
Interview Start:	
Interview End:	
Total Interview Time	

Request

"Hi. My name is _____ and I and working with the Museum. We would like to learn what people think about the *Star Wars* Exhibition. Would you be willing to answer a few questions? It should take about 5-10 minutes. **We have this small thank-you gift for your participation."**

Introduction

"Please be assured that all your answers are anonymous and confidential. Your name will not be connected with any of your responses or comments."

PRIMDES Primary Destination

1. What did you come to see in the museum today?
   (Circle One)
   1) To see the *Star Wars* exhibit
   2) To see the *Star Wars* exhibit ***again***
   3) To see the Extreme Screen movie
   4) To see "Big Machines"
   5) To see the museum as a whole
   6) Other, please explain _____

WHO

2. Whose idea was it to come to the museum today?
   (Listen and categorize)
   1) Respondent's idea
   2) Child's idea
   3) Date's/friend's idea.
   4) Husband's/wife's idea
   5) Another teacher's idea
   6) Other, please describe who _____

SAT Satisfaction

3. In general, how satisfied were you with the *Star Wars* exhibition?
   (Circle One)
   1) Very dissatisfied
   2) Somewhat dissatisfied
   3) Somewhat satisfied
   4) Very satisfied

PDA_USE PDA use in the Exhibit

5. Did you use a PDA/multi-media tour in the *Star Wars* exhibit?
   (Circle One)
   0) No
   1) Yes

OUT Outcomes

5. What three things will you remember about your visit to *Star Wars* today?

1) _____

2) _____

3)_____

SFLEV Level of Interaction with Staff

6. During your time in the exhibit, how frequently did you talk with museum staff members?
   (Circle One)
   1) Never ……**GO TO QUESTION 9**
   2) A few times
   3) Often
   4) Very often

SFROLES Roles of Staff in Visitor Interaction

7. In what ways did you interact with staff members?
   (Circle all that apply.)
   1) Stopped to see one of the activity carts
   2) Staff helped with difficult hands-on exhibit
   3) Staff provided additional information
   4) Staff asked me questions as I used an exhibit
   5) I had safety issues-please describe _____

SAT Level of Satisfaction with Staff Interaction

8. How satisfied were you with the level of staff interactions?
   (Circle One)
   1) Very dissatisfied
   2) Somewhat dissatisfied
   3) Somewhat satisfied
   4) Very satisfied

M_EDL Personally-designed *Maglev*

9. Which of the following statement best describes your experience in the *Landspeeder* area where people could build a *Maglev* car? (*If needed you may describe the location and nature of this experience.) (Circle One)
    1) I did not visit this area of the exhibition
    2) I designed my own *Maglev* car
    3) I worked together with someone else to design a *Maglev* car
    4) I observed someone designing a *Maglev* train
    5) Other, please describe _____

R_EDL personally-designed robot

10. Which statement best describes your experience in the *Robot Design Lab* area? (*If needed you may describe the location and nature of this experience.) (Circle One)
    1) I did not visit this area of the exhibition
    2) I designed my own Robot
    3) I worked together with someone else to design a Robot
    4) I observed someone else designing a Robot
    5) Other, please describe

    _____

ROBOTH *Robot Theater*

11. Which statement best describes your experience in the *Robot Theater* today? (Circle One)
    1) The line was long so I/we decided not see the *Robot Theater*.
    2) There was no line but I/we didn't go to the show.
    3) The line was long but I/we waited and went to the show.
    4) There was no line and I/we went to the show.
    5) Other, please specify _____

SATRTH Satisfaction with decision about *Robot Theater*

12. How satisfied were you with that decision? (Circle One)
    1. Very dissatisfied
    2. Somewhat dissatisfied
    3. Somewhat satisfied
    4. Very satisfied

    Record any comments: _____

BIGIDEA

13. If you were to explain what this exhibition is about to a friend, what would you say? (Write down key words in response.)

    _____

Next, we want to ask you about the extent you found out about new or exciting things as you visited the *Stars Wars* Exhibit. Please rate each of these areas on a scale of 1 to 10 from 1 -- found *"not much exciting*" and 10 -- "*a great deal exciting*". (Write number box.)

14.	**RLIMAG** The role of imagination and creativity in technological design	
15.	**SCIPHE** Scientific phenomena	
16.	**DPENG** Your own ability to actually DO engineering design	
17.	**DECTECH** The trade-offs in making decisions about new technologies	
18.	**RWTECH** Current, real-world technologies similar to those in the *Star Wars* movies	

SCICON Science Concepts Remembers

19. What are some of the scientific concepts or phenomena that you remember from the exhibit? (Write visitors exact words--key phrases.)

_____

_____

SCICONE Extent will explore science concepts

20. After today, to what *extent* do you think you will explore any of these the scientific phenomena you saw--on a scale of "1 = *won't explore at all* to "10 = *explore a great deal*"? (Write number in blank.)

_____

NTEC Explore trade offs new tech

21. On the same scale ("1 = *won't explore at all* to "10 = *explore a great deal*"), to what extent will you want to find out more about new, real-world technologies and their pros and cons?

_____

Demographics

In the next section, we will ask you tell us about yourself. We will use this information to make the exhibit better for visitors with a wide range of characteristics.

STLEV Level of Interest in Science and Technology

22. On a scale of 10 to 1 with ten being the highest rating, rate your interest in learning about science and technology? (Write number in blank.) _____

STKNOW Level of Knowledge about Science and Technology

23. On a scale of 10 to 1, with 10 being the highest rating, how would you rate your own level of knowledge about science and technology? (Write number in blank.) _____

SWINT Level of Interest in Star Wars

24. On a scale of 10 to 1 with 1 being the lowest rating and 10 the highest, how much of a *Star Wars* fan are you? (Write number in blank.) _____

VISFIR First Time Visitorship

25. Over the years, how many times <u>including your visit to see Star Wars</u>, have you been to COSI Columbus?

_____ **(If the answer is 1, GO TO QUESTION 28.)**

FREVIS Frequency of Visitation

26. Before coming to the *Star Wars* exhibit, when was the last time you visited COSI? (Circle One)

1) Within the last 3 months
2) 3-6 months ago
3) 6 months to within the last year
4) 1-2 years ago
5) 2-5 years ago
6) 5-10 years ago
7) More than 10 years ago

ure

PREEXH Attendance at Previous Exhibits

27. Did you see the Titanic exhibition at COSI last year?
(Circle One)
1) Yes
0) No

MEM Membership

28. Are you a member of COSI Columbus?
(Circle One)
1) Yes
0) No

GEN Gender

29. What is your gender?
(Circle One)
1) Male
2) Female

ZIP ZIP Code

30. What is your ZIP Code? _____

AGE

31. I am going to read several age groups, please stop me when I get to the range that contains your age. (Begin reading 3 ranges under a guess. Circle one.)

    1) Under 18
    2) 18-24
    3) 25-29
    4) 30-34
    5) 35-44
    6) 45-54
    7) 55-64
    8) 65-74
    9) 75-84
    10) 85 or older

GRPTYP Group Type

32. Who did you visit the *Star Wars* exhibition with?
    1) Group with children under 18
    2) Adults-only group (all members over 18)
    3) By myself
    4) School field trip/or youth group
    5) Other, please describe _____

COSI has an ongoing commitment to making our learning experiences accessible. For that reason, it is helpful to us to know about the types and nature of disabilities our visitors may have.

DIS Disability

33. Do you have a temporary or permanent disability? (Circle one.)
    0) No, I do not have a temporary of permanent disability.
    1) Yes, I have a temporary or permanent disability

DISKIND Kind of Disability

34. If you have a temporary or permanent disability, what kind is it? (Circle ALL that apply.)

    1) Not applicable
    2) Mobility
    3) Emotional
    4) Cognitive
    5) Visual
    6) Auditory
    7) Learning
    8) Other, please specify

    _____

EDUC Education

35. Please stop me when I get to the category that includes the highest level of education you have completed?
(Circle one.)

1) Elementary or middle school
2) High school
3) Some college
4) Two-year college
5) Undergraduate degree
6) Masters degree
7) Doctoral degree or equivalent

INCOME Level of Household Income

36. Please stop me when I get to the category that contains your estimated household income.
(Circle one.)

1) Under $30,000 per year
2) $30,000 to $40,000
3) $40,000 to $50,000
4) $50,000 to $75,000
5) $75,000 to $100,000
6) $100,000 to $200,000
7) $200,000 or above

ETH Ethnicity

37. With which of the following ethnic categories do you identify yourself? You may select as many as you like.
(Choose all that apply--you may circle more than one)

1) Black or African American
2) White or Caucasian
3) Asian
4) American Indian or Alaska Native
5) Hawaiian or other Pacific Islander
6) Hispanic or Latino
7) Some other race--please specify _____
8) Prefer not to answer

38. Within the next three months we are to conduct follow up interviews about the exhibition. We will be offering $5 gift certificates to store of your choice. Are you interested in being contacted for these interviews?
(Circle One)
0) No
1) Yes -- ask them to write name, e-mail, and phone number on the sheet. YOU write their tracking number on the card. Explain that the e-mail is to arrange the interview and send the gift card.

Thank you for taking the time to answer these questions. Here is a small gift to say thank you for your time.

APPENDIX D: IN-DEPTH INTERVIEW PROTOCOL

Data Set: _____

Materials: Before intercepting visitor groups, please make certain there are picture templates and drawing pens at the table. You will also need a watch, a clipboard, and a recorder.

Data Collector: _____ **Date: _____**
Interview Intercept Time: _____

Selecting Respondents
These respondents will be purposefully selected based on group type (*adult only* versus *groups with children*) and time of visit. See tally sheet before selecting.

Intercept Question
"Hi. My name is _____ and I and working with COSI. We would like to learn what people think about the *Star Wars* Exhibition. This interview will take about 10 to 20 minutes. We are offering free ticket vouchers for an Extreme Screen movie to thank people for the time. Would all of you [point to group] be willing to answer a few questions? We have things to talk about for both adults and younger people."

Screening [When needed to select respondent groups by time, as described below.]

Immediate Screening Question: We need to talk to people who stayed about X number of minutes. What was your ticket time?

Record Ticket Time: _____

If meets criteria: Great, we really want to talk to you.

If does NOT meet criteria: Thank you so much for your willingness to be interviewed. However, right now we really need to talk to people who have (longer/shorter) visits. Have a great day.

Selected Respondents
[Move them to the table and establish rapport as you walk. Remember their responses so you can jot them down in your notes.] Ask:

- Where are you from?
- Is this your first time at the museum?
- Are you big *Star Wars* fans?

Confidentiality and Anonymity

We want to audio record the interview so we can check our notes and make certain we have accurately understood what you have said. All your comments will be reported confidentially and anonymously. Do I have your permission to record? **[Turn on tape at this point.]**

Opening for with Groups with Children under 18

We want to talk with both young people and adults. I'd like to ask our younger visitors to draw me a picture that tells me about seeing the Star Wars exhibit. Here are some paper and drawings pens.

1. ***[For children]*** **Please tell me your names and how old you are.**
   Follow up. Would you please write your name and age, and draw a picture? While you draw, I have some questions. [Address to children] I'm going to ask your (mother/Father/grandparents, etc.) these questions but you can answer, too, if you would like.

Initial Adult Interview Questions:

Attraction

2. Tell me about how you decided to come to see *Star Wars* today.
   Probes:
   Who in particular wanted to come today?
   What was it that made them interested in coming?
   How did you find out about the exhibit?

SATISFACTION

3. What were the highlights of your visit to the exhibition?

4. What were some things that could have been better?

5. We want to know overall all how satisfied you were with the exhibition. Let's use a scale of 1 to 10 with 1 being "not satisfied at all!" and 10 being "absolutely the best exhibit I ever saw!" Based on that what number between 1 and 10 would you give your experience? (Ask everyone in the group to respond.)

   Follow up for each member of the group:
   What about the exhibit or your experience makes you give it that rating?

There a couple of specific areas in Star Wars that we want to talk with you about. These were areas where you may have built a Maglev car or designed your own robot. [Clarify if necessary.] Tell me what you did in those areas:

6. **Maglev EDL -** *Did you visit this area?* *Tell me what you were thinking when you decided to (stop/not to stop)?* *[If they used] How did people in your group use this area?*	**Outcome** **7. If you were going to tell someone the steps you went through to design your car--how would you explain it?**
8. **Robot EDL:** *Did you visit this area?* *Tell me what you were thinking when you decided to (stop/not to stop)?* *[If they used] How did people in your group use this area?*	**Outcome** **If you were going to tell someone the steps you went through to design your Robot--how would you explain it?**

9. Another area we are interested in is the Robot Theater. Tell me about what your group did in that area?
   Probes:
   What were you thinking when you decided [to go/not to go]?
   How satisfied were you with that decision?
   What were some things that were new or surprising you found out there?

10. We are also interested in the *Millennium Falcon*. Tell me how your group used that exhibit**.**
   Probes:
   What were you thinking when you decided [to go/not to go]?
   How satisfied were you with that decision?
   What were some things that were new or surprising you found out there?

11. In what ways did you interact with staff in the exhibition?
   Follow Up: How satisfied were you with that aspect of the exhibition?

12. What was your very favorite thing you saw or did in the whole exhibition?
    Probe: ***Why did you pick that?***

Outcomes and Impact

BIG IDEA

13. If you were going to tell a friend what this exhibit is about, what would you say?
    Probe: *Was it about anything else?*

ENGINEERING DESIGN PROCESS

14. In the Star Wars exhibit, people had a chance to design some technologies themselves. What kinds of things are involved when someone designs a new technology?

15. Very broadly, how would you explain to someone the steps in this process?

16. What parts of this process would you say are LIKE doing scientific research and what parts are not LIKE scientific research?

CURRENT AND* REAL-WORLD *TECHNOLOGIES

17. Another topic in the exhibit was about current, real-world technologies. What new or interesting things did you see there?
    Probes:
    Are there any of these new technologies that you would like to learn more about?
    Which ones?
    Where would find out about them?
    How likely do you think it is that you will ACTUALLY find out more about these after today?

PROS AND CONS OF NEW TECHNOLOGIES

18. Let's say there was a new technology that let you see and hear everything going on any part of your house at all times. Would you want to have this technology? Why or why not?

Children ONLY [Start with youngest child. Try to take at least a minute for each explanation.]

19. Now, I'd like to take a look at your pictures. First [younger child], let's take a look at your picture. Would you please tell me about your picture?
    Probes:
    What is this right here?
    Tell me about this?

[Repeat with next oldest child. Be CERTAIN the data set, gender, and age are on each picture.]

[Ask all group members under 18--adjust for age.]

20. Think back to what you saw in the exhibit. Did you see anything that gave you any ideas of things you might like to do as a job when you grow up?

21. Based on a scale of 1 being "*I wouldn't want that job at all"* to 10 being "*I think that would be the best job in the world,"* how interested would you be in designing new technologies like cars or planes that let people get from place to place?

Probe: *Why would you say that?*

22. Based on a scale of 1 being "I wouldn't want that job at all" to 10 being "I think that would be the best job in the world," how interested would you be in designing new technologies like robots?

Probe: *Why would you say that?*

Thank you for your help. We really appreciate getting feedback about exhibitions from visitors. Here are vouchers to the Extreme Screen movie to thank you for your time. [Give children small incentive, too.]

APPENDIX E: ACCESSIBILITY OBSERVATION/INTERVIEW

Data Set: _____

Case _____ **Data Collector**: _____

Date: _____ **Observation Start Time _____**

Introduction

- Allot one hour and 45 minutes maximum for exhibition observation. At that point, ask to go to the area outside of the exhibition to begin the interview. The interview should be approximately 20 to 25 minutes.
- Take observation notes on lined paper. Record general information on this form and record interview notes on this form.
- Get tickets to the exhibition before going to the lobby. Take instruments on a clipboard. Timing with your wristwatch is fine, but stopwatches will also be available.
- Meet the respondent at information desk in the Lobby. Make sure they get their parking voucher if need be before coming up to the exhibit.
- Use Tracking Instrument to help record your pathway through the exhibition. Attach it to your notes if you find it a useful way to document the observation.

Script: Hello, I am _____. I am an evaluator working with COSI to learn things about the *Star Wars* exhibit. Thank you so much for coming to help us today.

{Get names of all friends and family in visiting group with the individual.]

We are checking out the exhibit for accessibility so changes can be made before the exhibit travels. I want to join you as you visit Star Wars—primarily to follow along as another member of your group. I will take some notes and ask you some questions. Generally, I would like to visit the exhibit *with* you. I do want to time our visit, and map out where we go and the exhibits we use. [Show/indicate forms.] This observation and the interview will be confidential and anonymous. Your name will not be connected with any data or quotes in the report. However, this is a small group and you were recruited by the museum--so real anonymity is not a realistic promise I can make.

Do you have any questions about my role?

Do you have any questions about your role?

Social Group (describe):

Summary				**Total Number**
Person	**Gender**	**Age (observed)**	**Ethnicity**	Role (Mother, Father, Grandparent, Friend, Husband, Wife)
a. (focus person)				
b				
c				
e				
f				
h				
others				

Observation

Exhibition Start Time: _____ (Start when group enters exhibition.)

Universal Design Features

Consider the ways and extent the respondent benefited from the following universal design features:

1. Multi-Sensory Experiences: For example at *Maglev*, visitors can both feel and see the resistance.
2. Multi-modal approaches at same exhibit, e.g., text, audio, and images.
3. Images: For example at the EDLs there are line drawings with illustrations of how to use the exhibit components. Line drawings are easier to see for people with low vision. There is also some indication this is better for people with autism because it reduces distracting, non-essential details.
4. Architectural Designs: Such as attention to the height of the tables for people in wheelchairs, placing interactives close to the edge so they are reachable, placing labels where they can be read by people sitting or standing.
5. Clear Pathways: Pathways easily navigated by people in wheelchairs, e.g., *Millennium Falcon* is designed to be accessible for wheelchairs.
6. Mutual Benefit: Ways in which accessibility strategies for one group of people with disabilities may be helpful to other groups. For example, a woman with a non-verbal learning disability found the audio description for the blind very helpful. Individuals with dyslexia tend to be highly visual and images may be useful to them

Physical, social, intellectual and emotional aspects of the experience

Physical

- Map pathway through the gallery using a line with arrows.
- Draw a circle for major stops.
- Note any physical barriers that are difficult for the respondent.
- Note specific access devices used

Intellectual

- To what extent was the visitor able to fully engage intellectually with the exhibit? What facilitated intellectual engagement? What blocked engagement?

Social Engagement

- To what extent did the visitor need to depend on you or others to engage? Did the group talk about the content of exhibits? What was the topic of conversation? Was the visitor able to take a leadership role (content expert, good ideas for solutions to *EDLs*) at some point in the visit? What exhibit design features affected the social engagement?

Emotional

- To what extent did visitors find the exhibit emotionally satisfying? Did they have a good time? What was frustrating?

Interview

Keep in Mind the Overarching Questions:
To what extent and in what ways did the visitors engage successfully with the exhibit? To what extent and in what ways were visitors not fully engaged?

Opening Statement: Before you leave, could we sit down a few minutes and talk about the *Star Wars* exhibit. I would like to ask you a few questions. It will take about 10 minutes.

Confidentiality and Anonymity:
We want to tape record the interview so we can check our notes and make certain we have accurately understood what you have said. All your comments will be reported confidentially and anonymously. Do I have your permission to record? [Turn on tape recorder at this point]

Establish Rapport: [Ask while you are moving them to the interview area.]

1. Tell me a little more about yourself. (School, work, where living in area)

2. How often do you come to COSI?

3. Have you been to previous special exhibitions? Which ones?

Interview Questions

Emotional Engagement

1. Based on all the other exhibits you've used, how satisfied were you with this exhibit (1 being the least satisfying exhibits you've ever used, and 10 being the absolutely most satisfying). Remember, I didn't develop the exhibit--we are really trying to figure out what is working and what isn't. Why did you give it that rating? *[Listen very carefully to the reasons they give to understand the emotional aspects of their engagement.]*

2. What aspects of the experience did you find particularly satisfying or enjoyable?

3. What aspects of the experience did you find less satisfying?

Physical Engagement
(Clarify any questions from the observation.)

Social Engagement
(Clarify any questions from the observation)

Intellectual Engagement
4. Was there anything that surprised you in the *Star Wars* exhibit?

5. What were you thinking about as you left the exhibit?

6. If you were going to explain talk about the *Star Wars* exhibit to a friend, how would you explain it?

Labels

7. One thing the museum is curious about is how you used the text/audio information at this exhibit. Do you have any thoughts about that?
   Probes:
   Did you notice it when you first walked up?
   Which part?
   Did you look at it any other time as you used the exhibit?

Exhibit Design Features

8. What parts of the exhibit worked very well for you?

9. Were there any parts of the exhibit that you found particularly difficult to use?
   Probe: *Tell me why that was difficult.*

Ending Interview:

10. Do you have any questions you want to ask me? Thanks so much for your time!

Interview End Time: _____

APPENDIX F: DETAILED DEMOGRAPHICS BY METHOD

Quantitative Methods

Tracking & Timing

The tracking & timing sample of respondents (N = 125) were selected in a non-biased manner. The samples were quite similar at MOS and COSI, indicating that the exhibition tends to attract a specific visitor profile. This is good source to predict visitor profile for future exhibition venues.

At MOS, 61.8% of the tracking sample respondents were in *groups with children under 18 years old*, 23.5% were visiting the exhibit *adult only* groups, and 13.2% were adults visiting *alone*. At COSI, 71.1% of the individuals we tracked were visiting in *groups with children under 18 years old*, 26.4% were visiting in *adult only* groups, and only about 1.9% were individuals visiting *alone*. Less than 2.0% of the individuals we tracked were visiting as part of a *school field trip*.

Among *groups with children under 18 years old*, the number of children per group at MOS averaged 2.9 years old (SD = 6.8, n = 41) and at COSI 2.3 (SD = 1.1, n = 38). At MOS the observed age of these children was about 7.5 years old (n = 78) at COSI about 8.3 years old (n = 94). Children's ages were not significantly different. Gender information at MOS is incomplete because of an error on the tracking form. However, for those individuals for which we do have information, at MOS 57.5% (n = 23) were male and 42.5% (n = 17) were female. At COSI (where tracking information on this variable was complete), 54.5% were male (n = 13) and 45.8% were female.. The groups we tracked at MOS had an average size of 3.6 (SD = 6.3, n = 70) and at COSI 3.7 (SD = 1.5, n = 55). At both locations, the distribution of observed age was normally distributed with most respondents falling in categories between 30 and 54 years old—the age of many parents with children under 18.

Structured Exit Survey

All respondents to the structured exit survey were over 18 years of age. We drew most of these respondents from the tracking and timing sample, so the characteristics of these groups are fairly similar. We also used this source for the visitor profile. The only significant difference was in the percentage of respondents in *groups with children under 18 years old.* This was lower in the survey sample that the tracking & timing sample at both locations. This means that the structured exit sample will yield findings somewhat less representative for people visiting in groups with children. Respondents in groups with children were probably less likely to agree to stop and be surveyed than those in adult groups.

Given the high percentage of respondents attending with children, it is not surprisingly that 77.0% of respondents were between 30 and 54 years old. Respondents had relatively high levels of education and income. We found that 90.0% had college degrees and about 50.0% at both locations came from households with incomes over $75,000 per year. (Several respondents preferred not to answer the income item, thus the sample size for this item was 55 rather than the total sample of 70 respondents.) Among the U.S. population in general, the median household income is about $46,000 and only about 27% of the general population have an undergraduate college degree (U.S. Census Bureau, 2005).

We found more apparent ethnic diversity at MOS than COSI but the differences between the categories were not significant. At MOS, 78.6% of respondents identified themselves as white, 10.9% as Asian American, and 5.4% as Hispanic or Latino. At COSI, 90.3% identified themselves as white and 9.7% as Hispanic or Latino. Less than 3.0% of respondents in both samples reported disabilities. Samples of this size often under-represent groups in small groups in a population. Yet, overall, neither site appeared to have a diverse set of visitors in terms of ethnicity or people with disabilities.

Qualitative Methods

In-Depth Exit Interviews

We conducted 33 in-depth exit interviews with a total of 108 respondents. We conducted 16 in-depth exit interviews at MOS and 17 at COSI. We selected these respondents purposively to understand engagement in the exhibition among a wide range of social groups. Among these groups, the length-of-stay ranged from 15 minutes to a five-person group that stayed 170 minutes. Group size ranged from 1 to 15.

Table F.1: Detailed Demographics for In-Depth Exit Interview

Data Set	Location	Adults		Children		Total #	Group Type	Length-of-Stay (min)	Social Relationships among Group Members	Observed Ethnicity
		M	F	M	F					
STW2B_DI_040106_CO_1	MOS	1	1		1	4	*adults with children (under 18)*	45	Mother, daughter (11 years old) , toddler, and male boyfriend	White and African American
STW2B_DI_040106_CT_2	MOS	1	2	3	2	8	*adults with children (under 18)*	115	Two families--mother with 10 year old son and 1 year old daughter, and mother and Father with 9 year old son and 5 year old daughter	White and African American
STW2B_DI_040106_VC_1	MOS	1	1	2	1	5	*adults with children (under 18)*	90	Mother and Father with sons (8 and 5 years old) and daughter (3 years old)	White
STW2B_DI_040106_VC_2	MOS	1		1		2	*adults with children (under 18)*	105	Father and son (11 years old)	White
STW2B_DI_040206_CO_2	MOS		1		1	2	*adults with children (under 18)*	60	Mother with daughter (11 years old)	White

Data Set	Location	Adults		Children		Total #	Group Type	Length-of-Stay (min)	Social Relationships among Group Members	Observed Ethnicity
		M	F	M	F					
STW2B_Di_040206_CO_3	MOS	1	1	1		3	*adults with children (under 18)*	90	Mother, father, and son (10 years old)	White
STW2B_DI_040206_CO_4	MOS	1		2		3	*adults with children (under 18)*	120	Father and two sons (ages 10 and 8 years old) A boys' day out arranged by mother having friends over with new baby	White
STW2B_DI_040206_CT_4_	MOS	1		2		3	*adults with children (under 18)*	80	Father and two sons, ages 9 and 5 years old [Mother at home with new baby]	White
STW2B_DI_040206_CT_6_	MOS	1	1			2	*adults only (over 18)*	115	Adult couple in their 50s	White
STW2B_DI_040206_VC_3	MOS	1	1			2	*adults only (over 18)*	30	Father and son (18 year old college student)--both from CA	White
STW2B_DI_040206_VC_4	MOS	1			1	2	*adults with children (under 18)*	60	Father and daughter (11 years old)	White and Asian American
STW2B_DI_040206_VC_5	MOS	2				2	adults only (over 18)	80	Two men in their 60s who used an audio tour	White
STW2B_DI_040306_CO_4	MOS	2	1			3	*adults only (over 18)*	120	Girlfriend and boyfriend and another male friend (all in their 20s)	Asian American
STW2B_DI_040306_CO_5	MOS	1	1	2		4	*adults with children (under 18)*	105	Mother, Father, and two sons (ages 8 and 11 years old)	White
STW2B_DI_040306_CO_6	MOS	1	1			2	*adults only (over 18)*	90	Unmarried couple in their 20s and 30s who left exhibit early to meet friends	White and Hispanic
STW2B_DI_040306_CT_10_	MOS	1	1			2	*adults only (over 18)*	60	Boyfriend-girlfriend in their 40s. Exhibit was a birthday gift from him to her	White

Data Set	Location	Adults		Children		Total #	Group Type	Length-of-Stay (min)	Social Relationships among Group Members	Observed Ethnicity
		M	F	M	F					
STW2C_DI_070806_CO_1	COSI	2	2	2	1	7	*adults with children (under 18)*	15	Three generations - grandparents, mother two sons (11 and 5 years old) and a daughter 7 years old	White and Hispanic
STW2C_DI_070806_CO_2	COSI	1	2	1	1	5	*adults with children (under 18)*	170	Mother, daughter (14 years old), son (12 years old), aunt and uncle From Toledo and Cleveland, white	White
STW2C_DI_070806_CO_3	COSI	1				1	*alone*	105	Man alone but visiting with a family group, white	White
STW2C_DI_070806_CT_1	COSI		1		1	2	*adults with children (under 18)*	40	Mother and son, 9 years old	White
STW2C_DI_070806_CT_2	COSI	1	1			2	*adults only (over 18)*	90	Husband and wife in 30s who had brought visiting relatives	White
STW2C_DI_070806_CT_3	COSI	1	1			2	*adults only (over 18)*	65	Boyfriend-girlfriend, both 18, white from small town near Columbus	White
STW2C_DI_070906_CO_4	COSI	1	1			2	*adults only (over 18)*	45	Girlfriend-boyfriend in 30s in Columbus on business, from Toledo	White
STW2C_DI_070906_CO_5	COSI	1	1			2	*adults only (over 18)*	50	Boyfriend-girlfriend in early 20s, white	White
STW2C_DI_070906_CO_6	COSI	1	1	2		4	*adults with children (under 18)*	50	Boyfriend-girlfriend in late 40s with her two sons ages 12 and 8 years old	White
STW2C_DI_070906_CO_7	COSI	1		2	1	4	*adults with children (under 18)*	160	Father with son (15) and two daughters (14 and 6 years old),	African American

Data Set	Location	Adults		Children		Total #	Group Type	Length-of-Stay (min)	Social Relationships among Group Members	Observed Ethnicity
		M	F	M	F					
STW2C_DI_070906_CT_4	COSI	1		1	1	3	*adults with children (under 18)*	50	Father with 5 and 1/2 year-old twins: one boy, one girl	White
STW2C_DI_071006_CO_8	COSI	1	1	2	1	5	*adults with children (under 18)*	95	Mother, father, one son (13 years old), two daughters (16 and 11)	White
STW2C_DI_071006_CO_9	COSI	1	1	1	2	5	*adults with children (under 18)*	105	Father, mother, two daughters (12 and 7 years old) and son (9 years old)	White
STW2C_DI_071006_CO_10	COSI	1	1	2	1	5	*adults with children (under 18)*	165	Father, mother, two sons (twins 13 years old) and daughter (11 years old)	White
STW2C_DI_071006_CT_5_	COSI	4				4	*adults with children (under 18)*	75	Group of four male friends (18 to 22 years old) from Sidney, OH	White
STW2C_DI_071006_je_1	COSI	1		2	2	5	*adults with children (under 18)*	55	Father with daughter (11 years old) and her friends--female (age 12) and males (ages 15 and 11), out-of-state	White
STW2C_DI_071006_je_2	COSI	1		1		2	*adults with children (under 18)*	60	Grandfather and grandson (age 12)	White

1.09 Maglev Focused-Observations & In-Depth Interviews

At MOS we conducted five focus-observations followed by in-depth interviews to answer several questions about changes to the *1.09 Maglev EDL*. We selected respondents to get a full range of group type and engagement time. Engagement lasted from 36 minutes to 3 minutes

Table F.2.: Detailed Demographics for 1.09 Maglev Focused-Observations & In-Depth Interviews

Data Source Table	Adults		Children		Totl #	Group Type	Time of Engagement	Social Relationships	Observed Ethnicity
Data Set	**M**	**F**	**M**	**F**			**(min)**		
STW2B_FO_*Maglev*_040106_CT_1		2			2	*Adult only*	21	Two female friends in their late 40s	White and Asian American
STW2B_FO_*Maglev*_040206_CO_2		2	1		3	*Group with Children under 18*	11	Mother and son (10 years old)	White
STW2B_FO_*Maglev*_040306_CO_3		1		1	2	*Group with Children under 18*	7	Mother with daughter (7 years old) and daughter's same-age friend	Asian American
STW2B_FO_*Maglev*_040206_CT_3	1	1	2	2	6	*Group with Children under 18*	36	Father, mother, daughter (9 years old) and 3 attendees at her birthday party including a girl friend (8 years old) and two boys (9 years old)	White
STW2B_FO_*Maglev*_040206_CT_5	1	1			2	*Adult only*	3	Boyfriend (20 years old) and girlfriend (19 years old)	White
Total	**2**	**7**	**3**	**3**	**15**	**7**			

1.09 Maglev EDL Focused Observation and Brief Interviews

Also at MOS, we conducted a focused observation follow by brief interviews to learn more about the effects of crowding at *1.09 Maglev EDL*. We counted the total number of people in the area at timed intervals using the exhibit. We interviewed a total of 16 social groups with about 35 individuals who chose not to use the exhibit area. Social groups interviewed included 5 groups of adults alone, 3 groups with children under 6 years old, 3 groups with children 6 to 12 years old, 1 group with a child over 12, and 1 group of teens.

Accessibility Interviews—Demographics

MOS and COSI recruited these respondents from among their contacts in the community-based organizations to allow us to explore the accessibility of the exhibition for people with a wide range of disabilities. We conducted most interviews (7 of 9) in the context of a social group. One professional caregiver and 3 ASL interpreters were also part of groups with whom we visited the exhibition. These 9 datasets include 12 focus respondents with disabilities and other people with whom they visited the exhibition. This helped us understand the impact of accessibility issues on the social aspects of the visit. We visited the exhibition with 2 respondents who were deaf, 3 with blindness and low vision; 4 in wheel chairs with physical mobility disabilities, and two individuals with learning disabilities. Six of our interviews were with social groups including only adults over 18 years old, 2 respondents were alone, and one was with a child under 18 years old.

Table F.3: Detail Demographics – Accessibility In-Depth Interview Demographics

Data Set	Adults		Children		Total #	Group Type	Social Relationships	Observed Ethnicity	Focus Respondents
	M	F	M	F					
STW1_ACC_110405_CT/JE_A	1	2			3	*Adult only group*	Husband, wife, ASL interpreter	White	Deaf, male, 30s
STW1_ACC_110405_CT_B		2			2	*Adult only group*	Female friends	White	Blind, female, 50s
STW1_ACC_110505_JE_C		3			3	*Adult only group*	Respondent and caregiver	White	MS in wheelchair, female
STW1_ACC_110605_JE_D		1			1	*Alone*	Alone	Asian American	LD and ESL female, late teens
STW1_ACC_111205_CT_E	1				1	*Alone*	Alone	White	Low vision, male, late teens
STW2C_ACC_070806_je_A	2	1			3	*Adult only group*	Mother and son (18 years old) and friend	White and African American	Female with spinal cord injury (35) and male with paraplegia (55), both in wheel chairs
STW2C_ACC_070906_CT_B	2	2			4	*Adult only group*	Partners and ASL interpreters	White	Male, deaf (30s)
STW2C_ACC_070906_je_C		2	1		3	*Group with children under 18*	Director of Center for Independent Living (female, 50), daughter (31), and grandson (9)	White	Female with spinal cord injury in wheel chair; female with low vision; child with ADD
STW2C_ACC_071006_je_D		2			2	*Adult only group*	Daughter (55) and mother (75)	White	Low-vision female
Total	**6**	**11**	**1**	**0**	**20**				**12**

APPENDIX G: CHILDREN'S DRAWINGS BY TOPICS WITH GENDER AND AGE

In-Depth Interview	Location	Gender	Age	Topic1	Topic2	Topic3
STW2B_DI_040106_CO_1	MOS	female	11	Luke's hand		
STW2B_DI_040106_CT_2	MOS	female	5	figure with hand being cut off by light saber		
STW2B_DI_040106_CT_2	MOS	female	5	light sabers		
STW2B_DI_040106_CT_2	MOS	male	5	figures with light sabers		
STW2B_DI_040106_CT_2	MOS	male	10	light sabers		
STW2B_DI_040106_CT_2	MOS	male	9	Darth Vader with light saber	light sabers	
STW2B_DI_040106_VC_1	MOS	female	3	(did not talk about picture)		
STW2B_DI_040106_VC_1	MOS	male	8	Darth Vader with light saber	Yoda with light saber	
STW2B_DI_040106_VC_2	MOS	female	3	(did not talk about picture)		
STW2B_DI_040106_VC_2	MOS	male	8	fighters		
STW2B_DI_040106_VC_2	MOS	male	10	*Maglev* EDL		
STW2B_DI_040206_CO_4	MOS	male	10	*Maglev* EDL	*Robot Theater* narrator	Obiwan Kinobi
STW2B_DI_040206_CT_4_	MOS	male	10	Robots (3)		
STW2B_DI_040206_CT_4_	MOS	male	8	making the Robots		
STW2B_DI_040306_CO_5	MOS	male	10	Clone Troopers	Droids (R2D2 and C3P0)	
STW2B_DI_040306_CO_5	MOS	male	8	ships	light sabers	Droids (with wire out of top)
STW2C_DI_070806_CO_1	COSI	female	11	Yoda		
STW2C_DI_070806_CO_1	COSI	female	7	Princess Leia		
STW2C_DI_070806_CO_1	COSI	male	5	Yoda		
STW2C_DI_070806_CO_2	COSI	female	14	Darth Maul's light saber		
STW2C_DI_070806_CO_2	COSI	male	12	Yoda		
STW2C_DI_070906_CO_6	COSI	male	8	weapons display		
STW2C_DI_070906_CO_7	COSI	female	14	balancing robot	Wookie	
STW2C_DI_070906_CO_7	COSI	female	6.5	outside COSI		
STW2C_DI_070906_CO_7	COSI	female	14	Landspeeder		
STW2C_DI_070906_CO_7	COSI	male	15	Hyperdrive (MF)		
STW2C_DI_070906_CO_9	COSI	female	7	R2D2 (Robot EDL)		
STW2C_DI_070906_CO_9	COSI	male	9	X-Wing Fighter		
STW2C_DI_070906_CO_9	COSI	male	12	Luke's Landspeeder		
STW2C_DI_071006_CO_10	COSI	female	11	Walking Robot		
STW2C_DI_071006_CO_10	COSI	male	13	Kashyyyk weapons	tree display	
STW2C_DI_071006_CO_10	COSI	male	13	weapons display of props		
STW2C_DI_071006_CO_8	COSI	female	11	R2D2	3CP0	Wookie
STW2C_DI_071006_CO_8	COSI	male	13	Wookie		
STW2C_DI_071006_CO_8	COSI	female	16	Models of spacecraft	models of weaponry	workshops with robot items