Lessons from the Museum of Science's First Multimedia Handheld Tour: The *Star Wars: Where Science Meets Imagination Multimedia Tour*

Summative evaluation

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EXECUTIVE SUMMARY

Given its ongoing commitment to universal design and the integration of technologies into the museum experience, the Museum of Science decided to employ a handheld Multimedia Tour to accompany *Star Wars: Where Science Meets Imagination,* an exhibition about the real world meeting *Star Wars* technologies. With the help of leading tour guide developer, Antenna Audio, a 22-stop tour was produced featuring narration, *Behind the Scenes* interviews with individuals who had worked on the films, *Star Wars* film clips, still photos and the ability to send information home. An American Sign Language version of the Tour was also produced.

To explore visitor experiences with the Multimedia Tour (MMT), multiple methods of data collection were employed. Case studies and exit interviews were conducted with users and non-users of the Tour; an online survey was administered to individuals who retrieved their online bookmarks after the visit; and about ten weeks after their visit, follow-up phone calls were conducted. Web statistics and sales data were also collected.

The following are principal findings:

- 10% of all exhibition visitors rented the handheld Tour. Factors including interest in *Star Wars* and science and technology; positive previous experiences; curiosity; and others' recommendations influenced visitors' decisions to rent whereas cost, visitors' social group and a desire to have an independent experience were factors that led other visitors not to rent the Tour.

- MMT users tended to rate their level of *Star Wars* fandom greater than non-MMT visitors. Overall, they most valued the MMT for its *Behind the Scenes* interviews and *Star Wars* related content and felt the tour enriched their experience and allowed them to hear other perspectives. They did report, however, that it was confusing to find Tour stops and that the handheld was too touch sensitive. They also expressed that content should be more differentiated from the exhibit content.

- Non-MMT visitors found real world content to be most compelling. They were more likely to be observed using interactives and conversing; they reported remembering and learning about content that corresponded to real world technologies.

- Deaf visitors found the ASL tour to be empowering, giving them independence and access to content. However, additional cultural issues related to timing, learning style and norms need to be taken into account for future tours. They also recommended that the next handheld tour have more graphical content and keyboards and that tour content needs to be reexamined in the context of the deaf visitor.

- While only 10% of the MMT users bookmarked information to be sent home, in part due to lack of interest and understanding, nearly 40% of these individuals ended up picking up their bookmarks online at home. They valued the ability to round out their experience and found the technology "neat," but thought content could be more distinct.

In summary, the handheld MMT has much potential to enrich experiences. Science museums do have special considerations in promoting constructivist learning and future tours should feature more interactives and promote interactivity and conversation. The MMT and its bookmarked content must be more clearly differentiated from exhibit content and must more closely follow exhibition educational goals.

I. INTRODUCTION

With the rapid advancements of technology and the growing role of technology in society, museums have increasingly experimented with enhancing the visitor's exhibit experience in technologically innovative ways. More recently, with the miniaturization of technology, this experimentation has expanded to include the use of handheld devices. What began as experimentation with wand-based tours at the Exploratorium and the Experience Music Project's Museum Exhibit Guide has expanded into a barrage of new media technology being introduced into museums like the Smithsonian, Tate Modern, and Blanton Museum of Art, some of which are being produced by the public based on the latest set of technologies like PDAs, cell phones and iPods. In part, this explosion is due to the affordances that media based technologies provide (Norman, 1990), such as: greater opportunities for exploration with content at visitors' own pace and the ability to make meaning in a multiplicity of modalities through sound, video and text captioning capabilities. With the introduction of ubiquitous technology, the whole world ihas been transformed into an educational space without boundaries and access to information is instantaneous.

For several years now, the Museum of Science had wanted to incorporate handheld technologies into exhibitions. This growing trend toward incorporating handheld technology into museums, coupled with several key Museum strategic priorities, it seemed natural for the Museum of Science to host a handheld tour in its *Star Wars: Where Science Meets Imagination* exhibition. The concept of a handheld multimedia guide in the exhibition fit with film themes of promoting advancements in real-world technology that relate to technologies in the film (Hyde-Moyer, personal correspondence). On a larger scale, the exhibition fit well into the MOS's founding of the National Center for Technology Literacy, which spearheads the greater incorporation of engineering and technology into museums and the classroom nationwide. The anticipated gadget and kid-oriented *Star Wars* visitors were also viewed as a receptive audience for handhelds. All together, the *Star Wars* Multimedia Tour was a fitting research platform to see how the Museum of Science visitor population would respond to a handheld multimedia tour.

Museum of Science Goals for the Multimedia Tour (MMT)

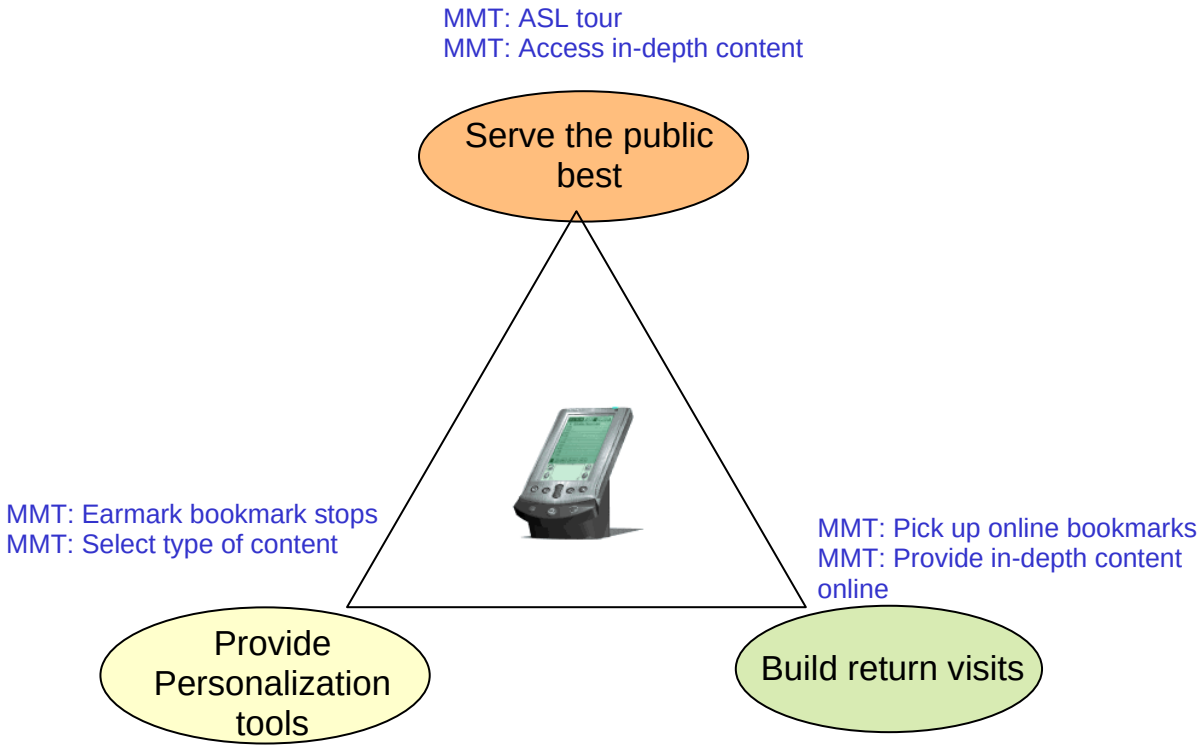
The Museum of Science's Multimedia Tour team outlined three specific goals they hoped the Tour would achieve:

1. Provide a means for delivering more in-depth levels of content for adult visitors interested in learning more about the scientific, technical and *Star Wars* related topics presented in the exhibition;

2. Facilitate connections between visitors' in museum and at-home learning experiences through an enhanced "bookmarking" feature that enables visitors to tag exhibition topics they would like to continue learning about at home; and

3. Offer visitors who are ASL users with a means of accessing information about the exhibition in their own language.

FIGURE 1 Model of Relationship between Multimedia Tour (MMT) Features and Three of the Museum of Science *Technology for the Visitor* Goals



The Multimedia Tour goals were an extension of the Museum's *Technology for the Visitor Plan* (see Figure 1 for mapping), which looks to increase the educational benefit of the visitors' Museum experience and were also reflective of current trends in technology (Labar, 2006). At the time of the Tour's development, the objectives of the *Technology for the Visitor* Plan were defined by providing technologies that embody the following characteristics:

1. *Personalization tools to allow the storage and dissemination of customized content that will appeal to the needs and wants of a diverse and changing public through varied delivery channels including the Internet, like Digital Take-Aways to extend the onsite visit to guests' homes or to people they know;*

2. *Incentives to enhance the relationship with individual visitors and build the pattern of return visits either through rewards or through increased participation, like simulations and games can be fun and educational*

permitting visitors to explore and experience phenomena that otherwise may not be accessible to them;

3. *Visitor convenience to serve the public best, providing support for the broadest possible audience, while supporting visitors with unique needs including Technology Enhanced Visits to ensure barriers to the visitor's educational experience are removed, Wearable Computers and Guides using wireless technology to assist guests and Audience Response systems to make presentations more interactive or powerful with customer feedback.*

4. *Commitment to new and existing infrastructure which ensures that the Museum is able to deliver the service expected by visitors, not only in the areas identified above, but through online ticket sales, integrated security and communications and by providing the necessary resources that allow the Museum to be most effective.*
*(*Worobey, 2005*).*

To further understand the affordances of the MMT, the next section examines other museums' experiences with such tours using the Tour's three goals as a framework.

Goal 1: Access to In-Depth Content

For the past 50 years, the linear audio tour, typically found in art museums, has presented content beyond what exhibits provide. The audio tour first brought label copy alive in 1959, exposing visitors to different perspectives and background information and helping draw out personal connections to the artwork. By merely listening to an audio tour, research found an artifact carries greater meaning to visitors and the content also stays with visitors longer (Maraj, Li, Hillman, Jeansonne & Ringenbach, 2003); by hearing the audio tour, visitors are more likely to recall content 30% of the time as opposed to simply reading the copy, during which they are likely to recall content only 6% of the time (Lucas, 2000). From the visitors' point of view, content is what leads to the tour's perceived success or failure (Proctor and Tellis, 2003).

For visitors who are interested in accessing more content, museums like the San Francisco Museum of Modern Art, the American Museum of Natural History, Walker Museum of Art and the Minneapolis Institute of Art, are now incorporating more technology into the gallery. Multimedia, unlike the audio tour, allows many different types of content to be presented, reaching different kinds of learners and ultimately, helping to increase learning. Multimedia content includes audio and video and captioning capabilities. It brings faces to voices, images of references to accompany their narrated descriptions, and clips of artifacts in creation. Furthermore, multimedia devices afford visitors the ability to choose how much and what content they wish to be exposed to.

After viewing the University of Texas's Blanton Museum of Art iTour, visitors reported greater learning than non-users (Manning & Sims, 2004). Evaluations found visitors were able

to describe the exhibit's works in greater detail, display a deeper level of understanding and critical thinking, make more personal connections to their background, and engage in more personal learning. Visitors most valued the ability to access more information, self-pace, hear artists talk about their work, and observe their works while listening to the audio content on the iTour.

Another affordance of multimedia content is the ability to promote interactivity, or greater social interaction and reflection as a result of interacting with technology. There are a growing number of projects at the Metropolitan Museum of Art, Getty Museum and Liberty Science Center, for example, which promote visitors' engagement and interaction with online and museum-based exhibits, which in turn respond to visitor input. With Cornell University's Human Computer Interaction group's Imprint tablet PC, visitors could receive additional content information about certain art objects from the galleries and leave an "imprint" drawing that was publishable to an online gallery. Many visitors enjoyed seeing others' images in the online gallery (Boehner, Sengers, Medynskiy & Gay, 2004).

Other museums like the Tate Modern have experimented with the idea of polling visitors, instant messaging and texting with members in the gallery and with visitors online at home (Wilson, 2004; Hoffmann & Goebel, 2003). In Cornell's HCI group's Birdscape project, the lack of visitors in certain areas of a gallery would set off a recording of birds chirping with the hope that visitors would notice and play with their positioning.

With so much access to content in addition to the exhibition's offerings, it is not surprising that multimedia guide users tend to spend longer in an exhibition than those without guides (Proctor, 2005). At times, these visitors have reported feeling distracted from interacting with exhibits and have been observed having lower levels of interaction (Semper & Spasojevic, 2002). The idea of reducing interaction with one's own social group conflicts with the predominant philosophy that an integral part of the museum visit is experiencing it with the individuals with whom one comes to the museum (Hood, 1983; Dierking & Falk, 2000; Borun, Dritsas, Johnson, Peter, Wagner, Fadigan, *et. al*, 1998; Leinhardt & Knutson, 2004; Ash, 2003; Leinhardt, Crowly & Knutson, 2002). Woodruff, Aoki, Hurst and Szymanksi (2004) tempered these reports by finding that interaction does still exist, but in different forms, such as visitor comments on content to group members and visitors' use of handhelds' speaker functions as opposed to headphones.

Goal 2: Facilitate At-Home Connections via Bookmarking Feature

Already, visitors are frequenting museum websites to follow-up their visit to the museum, view collections and seek out additional information about exhibits (Sarraf, 1999). Many other museums have experimented with the idea of "bookmarking," of having visitors earmark exhibits and information they are personally interested in and allowing them to retrieve the content online. Through this feature, not only could learning be extended and personalized, but even more people could be introduced to the museum's website as an educational resource.

The Exploratorium's Electronic Guidebook developers discovered that the "remembering" feature of the handheld was its primary strength because it promoted visitors to focus more on their experience using exhibits rather than focus solely on the handheld's content (Semper & Spasojevic, 2002). This feature had visitors photograph exhibits they enjoyed greatly and gave them a weblink to take home at a later time.

Seattle's Experience Music Project, which opened in 2000, employed a hip-pack and accompanying handheld to listen to music clips, hear explanations and also read text. There was also a feature that allowed visitors to bookmark information to a personalized website. Visitors would walk up to exhibits, point their guide up to the ceiling, and the Museum Exhibit Guide would deliver a piece.

The Science Museum of London uses an innovative fingerprint recognition system at exhibit stations called SAVE that allows visitors to mark what information they found useful. Its original goals were fourfold: to give visitors a souvenir of their visit, to help explore ways of building upon visitor relationships with the Science Museum of London, to enhance the personal uniqueness of the visit experience, and to provide visitors with an opportunity to use the latest technology (Vogiazou, 2001). By entering a password, visitors could see their personalized webpage later at home. Unfortunately, an evaluation of 44 users found that return rates for SAVE system users was particularly low, in part because users could not remember the webpage URL address (6 of 44 interviewees), did not understand the SAVE feature (1/3 of visitors) and had low interest in downloading bookmarks at home. Also problematic at times was the system's interface and integration into the exhibits.

In contrast, the Tate Modern's Multimedia Tour had more success in a bookmarking rate (40%; Fillippini Fantoni, personal communication, 2006) perhaps in part because visitors received a direct link to the website in their email inbox and because visitors gave their email addresses to docents to enter, rather than entering the information themselves.

Goal 3: Offering Deaf Visitors a Means to Access Information in their Own Language

With a growing commitment to universal design, museums across the nation are developing their exhibits and programs to be more inclusive of diverse visitor audiences (Hein, 2002; Reich & Lindgren-Streicher, 2004). Great strides have been made to include the deaf community, in particular, into museums' learning experiences. A survey sent out to science museums across North America found many institutions reporting a high level of accessibility for the deaf; 43% of institutions that responded to the survey self-reported that 75% or more of their exhibits were accessible to the deaf (Tokar, 2004).

With the proliferation of handheld multimedia tours in museums, there is potential to offer deaf visitors access to content in their primary language, American Sign Language, through PDAs' video and personalization capabilities. PDAs' affordances allow museum visitors to read copy label at larger sized fonts, display captions, and importantly, display sign language interpretation of exhibits.

Research has shown that deaf individuals might learn better when instructed in American Sign Language (ASL) than when being translated to (Lang, 2002), and with multimedia like PowerPoint presentations compared to traditional lectures (Lang & Steely, 2003; Dowaliby & Lang, 1999). Reading text labels can also be difficult for deaf individuals, with the high school graduate having an average fourth grade reading level (Hertzog, Stinson, & Keiffer, 1989; Smithsonian Accessibility Program, 1996; Holt, Traxler & Allen, 1997).

Already places like the Great Blacks in Wax Museum in Baltimore, the International Spy Museum in Washington, D.C., and the Tate Modern in London, have offered deaf visitors handheld ASL tours to access a wealth of cultural knowledge in their primary language.

Nancy Proctor of Antenna Audio (2005) wrote that sign language guides ultimately need to keep the deaf visitor inspired, learning and engaged in the exhibit:

Crucially, the Sign Language Guide is not a simple translation of a tour into a sign language…it goes beyond simple facts and information to interpret the object display, drawing the visitor into a three-way dialogue among the exhibit, the tour message about the exhibit and his or her personal reaction to both…To the extent it is possible, the pacing of the signed tour should be roughly equivalent to that of a spoken tour (p.3)

According to Proctor, a good sign language tour also has: high quality signers; a great story with appropriate drama; effect and atmosphere; subtitles to strengthen understanding; large text for low vision visitors; high contrast; and has a sign language glossary of new vocabulary. In terms of operations, it has a neck strap, awareness training for visitor services staff, and a signed instructional video at the distribution center.

Many findings were gained from the Tate Modern's British Sign Language Multimedia Tour, the world's first wireless sign language guide, which was originally implemented on an experimental basis. Their Tour and ASL version of the Tour featured special remarks by the Curator of Special Projects, quotations from artists, and interactive features like games and instant messaging to build a sense of community. Furthermore, there was an optional subtitling feature and a video glossary of art terms. Many participants of the evaluation's deaf focus groups voiced enjoyment of the tour and its video components, and found the overall experience empowering (Proctor, 2005). However, many participants reported that they wanted to see artists' perspectives. In addition, many found fluctuations in speed, rhythm and content delivery frustrating and believed that the advanced language could impede some users' understanding. One highly debated point was whether more information and fewer games should be provided because some members found value in the games while others did not.

Challenges and Opportunities Raised for the Museum of Science Multimedia Tour (MMT)

Taking other museums' previous experiences into account, the Museum of Science was inspired. The MMT team hoped to build upon other museums' successes and learn from their challenges to create a premier Multimedia Tour. The MOS viewed this technology as a vehicle to help extend learning within and beyond the museum walls. Yet the MOS tour differed

greatly from the Electronic Guidebook, SAVE system and Tate Multimedia Tour in several ways that made predicting its success difficult.

First, it was being made available in large quantities to the public. Unlike many of the other pilot-based evaluations, in which a limited number of handhelds were used for pilots, 200 handhelds were being equipped with the MOS's Multimedia Tour and hundreds of visitors were expected to the exhibition each day. For this reason, training to visitors by Antenna Audio staff had to be limited, so the design would have to be very intuitive and the hardware would have to be reliable.

Second, the content was developed by Antenna Audio at the same time the exhibit was being developed by Museum exhibit content developers, leaving the Tour developer largely with a set of guidelines to abide by, clips of information and interviews that did not make it into exhibit-based videos, and presumably many opportunities for the Tour to be repetitive or asynchhronous.

Third, it was a video and audio-based tour developed for an exhibit already rich in multimedia content; in fact, the exhibit offered lengthier interviews with *Star Wars* producers and staff. Furthermore, the exhibition was very hands-on. Would visitors be over-stimulated with too much information and things to do? The combination of these elements created a formidable set of challenges that the handheld would have to overcome to become a successful guide.

On the other hand, many opportunities presented themselves. First of all, the Museum expected many hard core *Star Wars* fans to visit and seek in-depth information about the way the film was made. Arguably, the Tour would make their experience much more enjoyable and informative. Furthermore, since this was already a very universally designed exhibition, which provided a multisensory experience for individuals of all abilities, the ASL tour brought accessibility to new heights, providing deaf visitors with an accommodation they had previously requested on multiple occasions in focus groups—content in their own language.

All together, in accompanying a high profile traveling blockbuster exhibition, the Tour could further advance the Museum's and the field's understanding of providing a high tech and accessible experience. With this being the Museum's first experience with handheld multimedia tours, bookmarking features, and ASL content, all of which were was packaged together, this MMT's success could mean development of tours for future special exhibitions and potentially for permanent exhibitions at the MOS and partnering museums. Visitors might also become more accustomed to and come to expect the affordances of handheld devices in enhancing their museum learning. Thus, despite the challenges, there was much potential in a handheld tour.

Description of Tour Development

The Tour content was developed on an accelerated basis. As Sonja Hyde-Moyer, then the Director of Advanced Technologies, wrote (2006), "This final approval [from Museum leadership] was granted seven months prior to exhibit opening. This is important to articulate,

because it was a very tight schedule within which to deliver a PDA tour, due mainly to the complexity of the project as compared to an audio tour, and also because in the last seven months before the exhibit opened, much of the Museum staff would have commitments to meet to deliver the exhibit itself." Scripts for the Tour were produced by a consultant for Antenna Audio. Online bookmark content was developed by the Museum of Science. Since funding and time were limited, no major prototyping of the handheld was conducted.

Tour and Hardware Specs

The Museum of Science's Multimedia Tour was 45 minutes long and contained 22 stops (see Appendix for breakdown of stops by exhibit). Within the stops, visitors could select one or two additional segments of information. In total, there were 40 segments (i.e., commentaries or interviews) which included 9 minutes of *Star Wars* video (from 7 clips) and 5 still photos. At each of the stops, there was the ability to "bookmark" stop information and send information home via a weblink to one's email address.

The Multimedia Tour hardware was a Toshiba E830 PDA which was 6.8 ounces and its dimensions were 5.3" x 3.0" x 0.6" (see Figure 2). It had an Intel XSCale 520MHz processor and TFT transreflective color display. The screen is high quality, with 480 by 640 VGA. The screen size was approximately 3 ¼" x 2 ¼". Its operating system was in French. There was a 5-way navigation button with four application buttons on the bottom of the PDA; however, the Tour was run with complete touch featured navigation and a T9 keypad (see Figure 2). No stylus was provided. The tour had pause, rewind, fast forward and help touch-based buttons.

FIGURE 2 Toshiba E830, Screenshot of T9 Keypad and Stop Menu

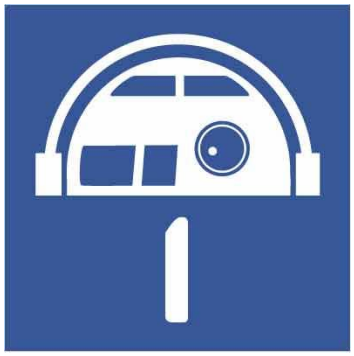
The ASL Tour featured nearly the same content as the hearing tour except a woman translates the narration into ASL. On the screen, you saw a blue background with a shot of the interpreter from the waist up (see Figure 3). The interpreter paused to highlight photos. The interviews with *Star Wars* producers, however, were not translated but instead displayed

captioning below the image of the person talking. To access the ASL Tour, Antenna staff had to manually switch the Tour's mode.

FIGURE 3 Screenshots of ASL Interpreter

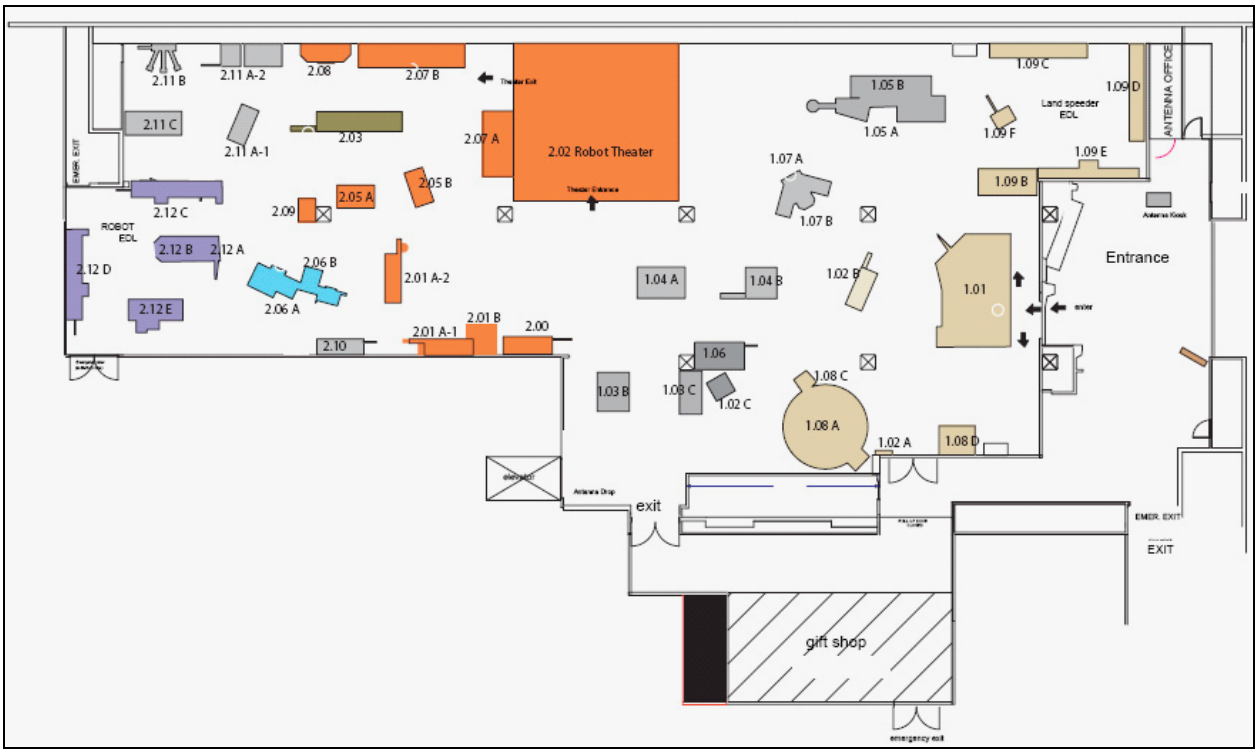
Tour stops were represented in the exhibition with a blue 2½" x 2½" square and a white outline of an R2D2 icon that wore headphones. These icons were placed throughout exhibit components and were not in consistent placements and sizes.

FIGURE 4 R2D2 Icon Indicating Multimedia Tour Stop



All content was stored on the handheld itself. A server was located at the exhibit exit and entrance which enabled bookmarks to be sent to the user and the machine to be reset after each use. In taking the design of the handheld into consideration, location based services done in other museums were not appropriate in the Museum of Science or at least in the gallery in which the exhibition was housed. Location based services rely on triangulating the signals from several access points in the gallery and there was not enough granularity for 22 stops, particularly because the tour was not linear and exhibits were multisided and back to back (see Figure 5).

FIGURE 5 Map of *Star Wars: Where Science Meets Imagination* Layout



Brief Exhibition Description

The *Star Wars: Where Science Meets Imagination* exhibition was a major traveling exhibition developed by the Museum of Science. It was designed to raise visitor awareness of technological developments that might make technologies in the *Star Wars* film a reality one day through two major themes: getting around and getting along with smarter machines (Museum of Science, 2005). Models, props, film clips, video interviews, and interactive exhibits were featured. In total, there were 44 exhibits, of which 11 were interactive: "Hands-on interactive exhibits will allow visitors to explore scientific phenomena of the real-life 21st century that could lead to a real technological solution to the challenge posed" (Museum of Science, p. 3). The two engineering design challenges, which featured building and testing a robot or a maglev car at multiple stations, were considered the principal interactives. Approximately 15 exhibits had multi-part exhibit videos that featured *Behind the Scenes* interviews. Hearphones accompanied all exhibits to provide physical descriptions of the exhibit and to give instructions; their original purpose was to make experiences accessible to all.

II. METHODS

This evaluation sought to answer the following research questions:

- In what ways, if any, are the visitors who choose to rent the Multimedia Tour different from those who do not?
- How do visitors integrate the multimedia tour into their learning experience in the museum and at home?
- What do visitors perceive to be the greatest value of the Multimedia Tour?
- How is the *Star Wars*: *Where Science Meets Imagination* experience different for users of the Multimedia Tour as compared to non-users?
- What suggestions do visitors have for future implementations of this type of tour?

Data Collection

Different museums have relied on a variety of methods to evaluate the handheld technologies. They have ranged from a survey at the end of the tour on the handheld (Tate Modern evaluation, iTour) to observations and recordings of the users' conversations for analysis (Woodruff, 1997). The Museum of Science often uses a grounded theory approach, to capture participants' perspectives as closely as possible. This study utilized a mixed-methods approach to provide a holistic view of the visitor's experience related to the Multimedia Tour. Table 1 summarizes the types of data collection methods that were employed and the questions these methods aimed to address. Following the table is a more detailed description of each major data collection method.

TABLE 1 Summary of data collection methods

Questions:	Sales data	Time data	Bookmarking statistics	Web surveys	Exit interviews	Follow-up interviews	Case studies	Deaf focus groups
In what ways, if any, are the visitors who choose to rent the multimedia tour different from those who do not?	X	X		X	X			
How do visitors integrate the multimedia tour into their learning experience in the museum and at home?		X	X	X	X	X	X	X
What do visitors perceive to be the greatest value of the multimedia tour?				X	X	X		X
How is the *Star Wars: Where Science Meets Imagination* experience different for users of the multimedia tour as compared to non-users?		X	X	X	X	X		
What suggestions do visitors have for future implementations of this type of tour?				X	X			

Sales data

Sales data collected by both Antenna and the Museum of Science's Information Services department provided information related to the type and number of visitors who purchased the Multimedia Tour over the course of the exhibition run at the Museum of Science. The sales data included the number of audio-only tours distributed for children and/or members and for non-member adults by day. It also provided the number of Multimedia Tours sold as compared to the number of exhibition tickets sold.

Bookmarking statistics

The number of emailed bookmark links Antenna sent out was recorded. Web log data was also collected by the Museum of Science Web and New Media department from the exhibit opening, October 27, 2006 to a month after its closing on May 30, 2006. These data provided an indication of the number of times each stop was bookmarked by Museum visitors, and the percentage of times those stops were visited by Museum visitors at home using the Museum of Science website. This data was captured for all Multimedia Tour visitors.

Exit Interviews

76 museum visitors who used the Multimedia Tour and 76 Museum visitors who did not use the Multimedia Tour were interviewed as they exited the exhibition. The exit interview included both quantitative and qualitative measures pertaining to the research questions presented above. Every third person who exited the exhibition was approached and interviewed if he or she was an adult or a child over the age of 10 who had attended the exhibition with an adult who could provide legal consent. Two data collectors interviewed MMT users from December 9, 2005 to January 7, 2006. Non-MMT users were interviewed from January 13 to February 17, 2006. Data was collected largely on Fridays and Saturdays.

Responses to each exit interview question tended to be relatively short and thus, analysis was performed per question. Emergent themes were identified, assigned and then tallied. The validity of codes were checked by a second researcher and an intercoder reliability level of 80 percent was achieved. Because we were unable to interview individuals under the age of 10, it is possible that we did miss out on a more accurate representation of the exhibition experience for visitors under 18.

Web surveys

Museum visitors who visited at least half of their online bookmark stops were asked to participate in a web survey. This largely quantitative survey asked visitors about features they found the most valuable, entertaining, or useful about the exhibition, Multimedia Tour and bookmarks, and also solicited visitors' demographic information. 95 surveys were collected from November 1, 2005 to February 14, 2006. From mid-February to late March, an Antenna Audio glitch occurred and MMT-users were not sent their bookmarks. Thus, data is analyzed up until that that point. In total, once the system glitch was resolved, the survey response rate

was 11 percent (139 of 1,236 bookmark users). Demographics collected across the three exit interviews and web surveys were compared and analyzed using chi square, Kruskal-Wallis, and Mann Whitney U tests depending on the number of groups being analyzed and if the data was continuous or categorical.

Follow-up interviews

Typically ten weeks after completing their exit and online interviews, visitors were contacted to see if they would be interested in a follow-up interview.[1] Twenty three of these visitors responded and were re-interviewed. Visitors were asked about their experience using the Multimedia Tour and about long-term memories and learning related to the exhibit. The interviews in particular focused on whether the visitors were more likely to remember the stops visited that had corresponding information on the tour as compared to those stops that did not.

Interviews were coded using a constant comparative analysis approach, testing a set of codes against visitor responses to seek validity. However, with a small self-selected sample and a purely qualitative analysis approach, the findings have limited generalizability.

Case studies

6 visitor groups who used and did not use the Tour were observed in the gallery to gain a fuller understanding of their experiences from February 17 to March 10, 2006. Four observations were of family groups and two were of adult-only groups, representing the relative breakdown of visitor group types to the exhibition. These cases provided a description detailing different ways visitors integrated the Multimedia Tour into the group's learning experience. Case studies were examined holistically and analyzed based on finding emergent patterns and themes. A limitation that must be considered was the day the data collection took place: Fridays were the weekdays with the most MMT traffic, but compared to weekend days, were relatively quiet inside the exhibition.

Deaf focus groups

On two Saturday mornings, December 3 and December 10, 2005, 16 deaf adults were invited to participate in a focus group to try out the Multimedia Tour in the *Star Wars* exhibition and provide feedback on both its effectiveness and how it could be improved. The focus groups were advertised twice on Mass Deaf-Terp (http://groups.yahoo.com/group/Mass_Deaf-Terp/), an online community that posts local social events and news items of interest to the deaf community. In exchange for joining a focus group, participants were offered free admission to the Museum, *Star Wars* exhibition and parking, and a MMT.[2] Visitors spent 90 minutes in the exhibition and then 60 minutes in a focus group. Two ASL interpreters were present the entire time. The purpose of the focus group was to gain rich in-depth feedback from many people at once, particularly because it was difficult to capture deaf users in our exit interviews. Focus groups followed a topical framework surrounding what visitors enjoyed about the handheld,

[1] The actual interview time ranged from six to 15 weeks after their visit due to difficulties in recruiting enough individuals

[2] The MMT was offered for free to any blind or deaf visitors in general.

improvements they might make to the handheld's design, and marketing the tour to the deaf audience (See Appendix). A limitation of focus groups is that they are in an inherently social setting and lend themselves to bias by other participants; participants might be less likely to disagree strongly to others' comments and instead conform to the norm, especially if one person is particularly persuasive. Having two focus groups allowed us to test the popularity of ideas that arose in the first focus group with the second.

RESULTS

According to Antenna Audio sales records, a total of 32,158 Multimedia Tours were sold. In total, 10% of all exhibition visitors rented the Tour. Compared to the general exhibition visitors, the MMT users' experience was in the minority. More Tours were sold at the child, member and senior rate of $4 (N=19,776) than the full-priced adult rate of $5 (N=12,990).

All survey instruments and interview open-ended response coding can be found in the appendices.

1. DEAF ASL FOCUS GROUPS

Most of the deaf focus group participants were in their thirties, with the youngest person being 18 and the oldest being 40. Overall, there were slightly more males (10 of 16, or 63%) than females. With the exception of two individuals, most participants rated themselves as having a very high interest in science and technology and *Star Wars*. One member from each of the focus groups also had low vision.

1.1 Participants' Experiences in Gallery from Start to Finish: Enthusiasm, Difficulties and Different Types of Users

Before signing up for the focus group, none of the participants had heard about the Museum of Science's Multimedia Tour. Upon seeing the Antenna Audio display of handhelds physically paired with headphones hanging outside the exhibition, many of the participants still assumed that the Multimedia Tour was for hearing visitors only. Yet once they learned more about the Multimedia Tour ASL version from Antenna Audio staff, many participants were thrilled with the idea that they would be experiencing the exhibit in their native language with one person declaring that they were pioneers.

Participants' experiences showed that the introductory video on the handheld and the interpreted explanation the Antenna staff gave on how to use the handheld was insufficient. Some participants still did not understand the full capabilities of the handheld, such as how to enter their email addresses, how to access the Tour's help menu, turn off captioning, or pause the video feed. Furthermore, the Antenna staff member on shift for the second focus group seemed unprepared to explain the device to deaf visitors. The visitor services staff member was so taken off guard that the translator explained his awkward silence as not knowing what to say.

As was the case with users of the hearing Multimedia Tour, once inside the exhibition, there were several types of Tour users. Some individuals used the Tour heavily and were absorbed in the content while others barely used it because they were engrossed in the exhibition and reliving their childhood (Sam, 12/3/05) or were uncomfortable with the neck lanyard (Jenny, 12/10/05) or disinterested in the handheld's offerings. Some group members split up for the majority of the time inside the exhibit while others stayed close together, especially the

individuals with low vision who had trouble navigating without a partner. Most participants ended up going inside Robot Theater, which unbeknownst to them, was not captioned or featured on the handheld.

1.2 ASL Tour Affords Independence and Access to Information; Participants Have an Overwhelmingly Positive Reaction to Tour

To all focus group participants, the ASL handheld Tour was personally significant in many ways. On one level, the ASL Tour represented museums' opening of their doors and embracing the deaf as valued visitors, and of becoming more inclusive places. One woman was convinced that the MMT meant "a lot of changes are coming" to exhibitions and programming (Rebecca, 12/3/05). For what felt like the first time, museums were openly recognizing the deaf as a very important population by incorporating specific deaf-friendly components into their exhibits; it was a warmly received gesture.

On another level, many deaf individuals declared that the handheld provided access to an experience they normally would not have: a sense of independence and control over what they saw, did and learned. Not only did they not have to arrange for an interpreter, which requires weeks of advance notice, but they did not have to follow an interpreter at the interpreter's pace. They also did not have to rely on other hearing members of their group or basic handouts like maps: "I've been to several science museums and felt my only option was the map. I found out after the fact that there was a lot more information available to me. I had to rely on [the] hearing person who was with me" (John, 12/10/2005). The ASL Tour "let me go at my own pace" and explore topics of interest at greater depth like any other visitor: "I enjoyed the *Lord of the Rings* [exhibition at the Museum of Science], but in *Star Wars*, I just felt like the general public. I like that ready access" (Jim, 12/10/2005). Interestingly, although the Museum and general hearing public conceptualized the handheld as an add-on, providing additional information to the visitor's exhibit experience, to many deaf individuals, the handheld represented equal access to the exhibition's content information. When asked how their experience without the handheld would be different, participants answered simply, "We wouldn't have any information" (Linda, 12/10/2006).

In addition, the handheld provided deaf visitors with access to some form of information they might have missed out on or had difficulty gleaning from the exhibition due to crowding. If they wanted to watch a video, for example, they did not have the luxury of standing three or five feet away and listening while peeking over other visitors' shoulders. Instead, they would have to stand close enough to see the captioned text: "If [this information] was part of the exhibit, I might have to wait in line" (Jim, 12/10/2005). They liked having individual tours of their own.

Participants brought up the idea of how wonderful it would be if the Museum of Science had a handheld that extended throughout other exhibit halls. One participant, Aaron, wanted to see a noticeable kiosk or information booth that alerted deaf visitors to all of the Museum's offerings for the deaf. Maybe it could have wayfinding mechanisms and help visitors locate exhibits and show times. Moreover, participants thought it would be amazing if all museums had an ASL

tour. Both focus groups wanted to see the Museum move in the direction where handheld devices would be ubiquitous and comprehensive.

1.3 Issues Arise with the Handheld's Captioning, Keyboard, Display Design

Previous handheld museum tours have presented problems to the general public by dividing visitors' time between the handheld, engagement in exhibits and interaction with group members (Semper & Spasojevic, 2002). Museums had responded by keeping Tour stops short and providing an opportunity to send information home. Yet for the focus group participants, this ASL Tour still seemed to divide their experience and to a greater degree than hearing users. Many deaf handheld users felt they had to continually "Look up and down" (Jenny, 12/10/05) and to make a choice between what to see; unlike hearing visitors, they did not have the option to listen and watch at the same time. One woman's comment captured this sentiment when she said, "I feel like I'm just looking at text versus experience, so I have to choose. I don't like having to choose" (Danielle, 12/3/05). There were many factors that contributed to the handheld's divisive nature and focus group participants spent much time suggesting ways to alleviate the problem.

Part of the problem lay in the captioning, which lagged a second or two behind the signing and was constricted by the small space of the handheld's screen, allowing only 5 or 6 words to appear at a time. Thus, the deaf user felt as though he or she would have to wait for the next few words to show up on screen to get the full message – making the handheld experience feel like a drawn out and tedious process. Both focus group participants wanted more captioning options like having multiple lines displayed at once. This would allow visitors to read the stop quickly instead of waiting for each line to appear; others however thought captioning should stay consistent to the TV's standardized single-line closed captioning presentation. One man, Jeff, wanted one or the other – captioning or ASL – but not both: "Maybe it should be an option to the person using it, to have text or signing, but not both – that would cut off some of the time" (12/10/2005). (In actuality, there was an option to turn off the closed captioning, however he and many others had not been aware of that function.)

Others suggested having "a supplemental guidebook so we don't have to wait for each fact to come to you in the PDA" (Manuel, 12/10/2005) and instead they could instead turn to a booklet to find the key points made in each clip. These comments reflected the different preferences of text presentation and the diversity of the deaf community. As one woman reminded us that "we have a broad deaf community" and furthermore, not everyone is fluent in ASL; thus, "combinations are helpful" (Linda, 12/10/2005).

Another aspect that contributed to the handheld's divisive nature was the length of the videos. Some suggested shortening the clips: "It would be nice if [the] experience on [the] PDA is shorter. [You experience] some fatigue after watching for 3 hours. Your eyes would fall out. I'm not saying reduce it to a Mickey Mouse book" (Mitt, 12/3/2005). Some deaf users emphasized that it is not necessary that the ASL interpreter translate the interview so closely.

Instead, the interviewee's comments could be translated in abbreviated fashion, thus shortening clips.

The second focus group simply expressed wanting more than 90 minutes in the gallery. Nearly all individuals from both focus groups felt that 90 minutes in the exhibition was too short to be using the handheld and experiencing the exhibition; many who had used the ASL Tour felt they were looking "at the PDA not the exhibit" during their visit (Matt, 12/10/2005). Many said they felt they could spend all day in the exhibit exploring content (with one man joking that he would love to sleep over in the exhibition to access its content undisturbed by other visitors) and that the exhibit experience should be advertised as such.

This is interesting to contrast with the hearing Multimedia Tour users, whose median time of 85 minutes in the gallery, albeit based on a small sample, was close to the focus group's allotted time in the gallery (Tisdal, 2006). This difference highlights how people with disabilities tend to take longer in exhibits, as Tisdal's remedial exhibition evaluation (2006) and other research has well established (Reich, 2005).

To make the ASL Multimedia Tour more engaging and more integral to the exhibition experience, the Tour should have images of the artifacts they were looking at, playing to deaf people's visual orientation. Many participants emphasized how deaf people find visuals extremely compelling and one person said for this reason, he loves coming to the Museum of Science to see phenomena in motion.

Both focus groups unanimously agreed that the "signing image was too small" and that the videographer should have "zoom[ed] in" to see the interpreter from the waist up (Jeff, 12/10/2005). The screen size, in and of itself, could have been larger as the handheld's screen was only 3 ¼" x 2 ¼" and the ASL image was 1¾" x 1 ¼". It is important to remember that many deaf individuals, such as those with Usher's Syndrome, also have low vision; two of the focus group members had low vision and one member in particular had difficulty viewing the handheld's images.

One way to incorporate the aforementioned suggestions of increasing image size and greater captioning options would be a horizontal screen. A man from the first focus group, Sam, argued that with a landscape or horizontal screen, "you can use high definition and have an option of… Quicktime," and make its use more efficient with "4 lines of text sequencing instead of [a] linear [presentation]" (12/3/05). This idea of having more options through a horizontal screen appealed to nearly all members of Sam's group after some debate, but less so to the following week's focus group because it wouldn't be as ergonomic and would seem more Gameboy-like. Some members felt that the horizontal versus vertical orientation could again be a matter of the user's personalization, depending on one's preferences, and perhaps could be another option they could choose from.

1.4 Inconsistencies with the Design of the Exhibition Being Deaf Friendly

With the existence and use of the ASL handheld for the exhibition, it was surprising to the participants that the design of the environment was not always accessible. While these particular focus groups did not focus on the *Star Wars* exhibit itself, some important comments arose about inconsistencies and how the handheld could play a role in addressing these problems. Visitors expressed frustration at not understanding what was going on at the interpretation carts: "there was no sign [so] I didn't know what it was about [and] I didn't know how to participate" (Rebecca, 12/3/05). The handheld might include text-based information on those specific carts as well as general information on what those carts were.

Another contentious issue, in particular for the first focus group, was the Robot Theater exhibit. Many were surprised to find absolutely no captioning – they had assumed the Theater, like the rest of the exhibits, would have captioning. "I almost fell asleep a couple of times," Ken said of the exhibit (12/10/2005). Suggestions were to have "possible uses of PDA in theater" (Mitt, 12/3/05) or "have a special light design for an interpreter." One man suggested drawing inspiration from the Blue Man Group, a live performance production, in which they use a "red enhanced LED light at the lower end of the stage" to have captioning that is not distracting the rest of the audience during the show. Anything would have helped the experience" (Rebecca, 12/3/05). Another person said even having scripts and flashlights to follow along would have made the experience better.

Once inside the exhibition, both focus groups experienced difficulty finding the R2D2 Tour stop signs. The signs were admittedly small, being only 2½" x 2½". People felt they had to do "a little bit of work" finding the signs and requested that they be "a little bit bigger," "a brighter color," and "let people know certain exhibits are not on the PDA" (12/10/05). When they entered the exhibit, many had expected some logical ordering of stops, but the "numbers weren't in any particular sequence" (Mark, 12/3/05).

1.5 Marketing the Multimedia Tour through Channels Deaf Use

According to Antenna Audio, 77 deaf and blind visitors took advantage of the free Multimedia Tour; however, 16 of those individuals had come as part of our deaf focus groups or Museum-related access feedback (Smith, personal correspondence, 2006). Clearly, there is much room for growth in outreach to the deaf community, especially given the Museum's large investment in the ASL tour and dedication to serving diverse communities. Nationally, there are an estimated one million people who are functionally deaf (Mitchell, 2006), 421,000 people who are deaf in both ears, and in Massachusetts, an estimated 22,255 individuals who are unable to hear normal conversation (US Census Bureau as cited by Harrington, 2004).

The importance of marketing to the deaf community should not be underestimated. Part of deaf culture is a history of exclusion from the hearing society. Unless members were explicitly told something is accessible, deaf individuals will assume it is inaccessible (Barnes, 2003; Gill, 1999). Focus group members largely appreciated having the Tour and all believed there should

be greater levels of advertising. None of them had known about the Tour prior to the focus groups. All agreed that the best way to tap into the community was through word of mouth. One man, Jeff, was on an advising board for a deaf community organization and viewed himself as "an instrument" to tell people what he knew (12/10/05). Another man, Mitt, suggested making flyers and passing them around deaf community groups, as the flyers would exchange hands frequently and make their way through different groups (12/3/05). Other suggestions included taking the ASL Multimedia Tour to deaf expos and giving out free Museum of Science passes to the deaf community to create buzz. Both groups also thought the exhibit webpage should more clearly outline the fact that the ASL handheld was available and moreover, free to the deaf community.

Both groups expressed the power of images in marketing. How an advertisement is presented has deep implications to the deaf community because without seeing a captioning or interpretation symbol, deaf individuals naturally assume it is not deaf friendly. Even the pairing of the headphones with the PDAs outside the *Star Wars* exhibition signified to many deaf participants that it was not designed for them.

All advertisements in the *Boston Globe*, magazines and billboards should prominently feature symbols signifying exhibitions being captioned with a handheld interpreted in ASL (see Figure 1). Moreover, the MMT's advertisement sign outside the exhibition should have interpretation and closed captioning signs. Unless visitors heard about the ASL Tour from a disability-related newsletter article that featured the exhibit's universal design, it was not reasonable to expect the general deaf public to be knowledgeable about the handheld.

FIGURE 6 Open Captioning and Interpreter Symbols

Finally, in advertising events and exhibitions to the deaf, it is important that we give plenty of advance notice of events. Mitt emphasized this point by saying "As a deaf person, it takes me a much longer time to be able to get to a one-day sale" (12/3/05).

1.6 In Summary

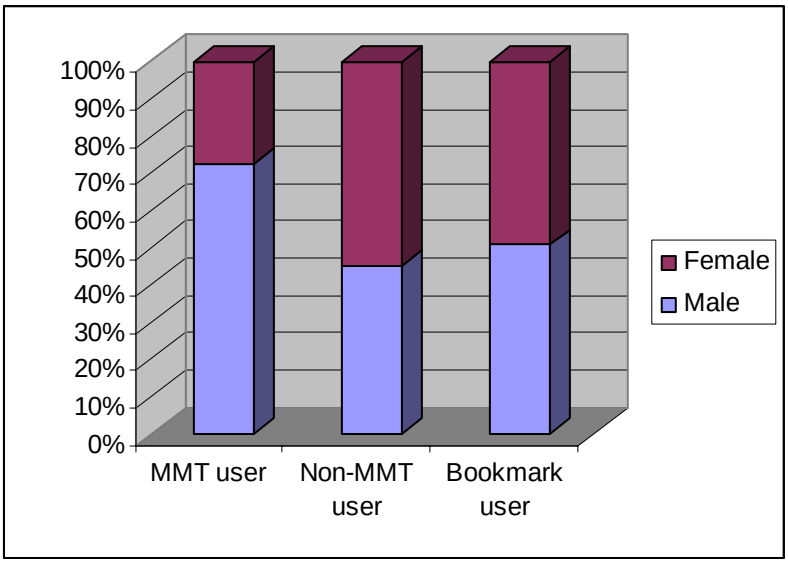
While deaf focus participants greatly appreciated the Tour and viewed it as a symbol of welcome, they had many suggestions on how to improve its design to make it more watchable for deaf Tour users. According to participants, the Tour was a step in the right direction, but at the same time, was far from perfect.

2. IN WHAT WAYS, IF ANY, ARE THE VISITORS WHO CHOOSE TO RENT THE MULTIMEDIA TOUR DIFFERENT FROM THOSE WHO DO NOT?

2.1 More Males Rent the MMT than Females

Similar to Tate Modern's pilot Multimedia Tour findings (Proctor, 2004), of the 76 exit interviews we conducted, it was found that significantly more males rented the MMT than females (see Figure 7). To confirm this initial finding, Research staff observed visitors who picked up or purchased Tours over the course of four Saturday afternoons (1/21/2006 to 2/18/2006). Of the individuals were observed approaching the Antenna front-desk to pick up a Tour and approximately 131 (65%) were males and 72 (35%) were female.

FIGURE 7 Gender by Group Type



**Note: Gender difference is significant,* $x^2(1,N=73)=11.4$, $p<.001$

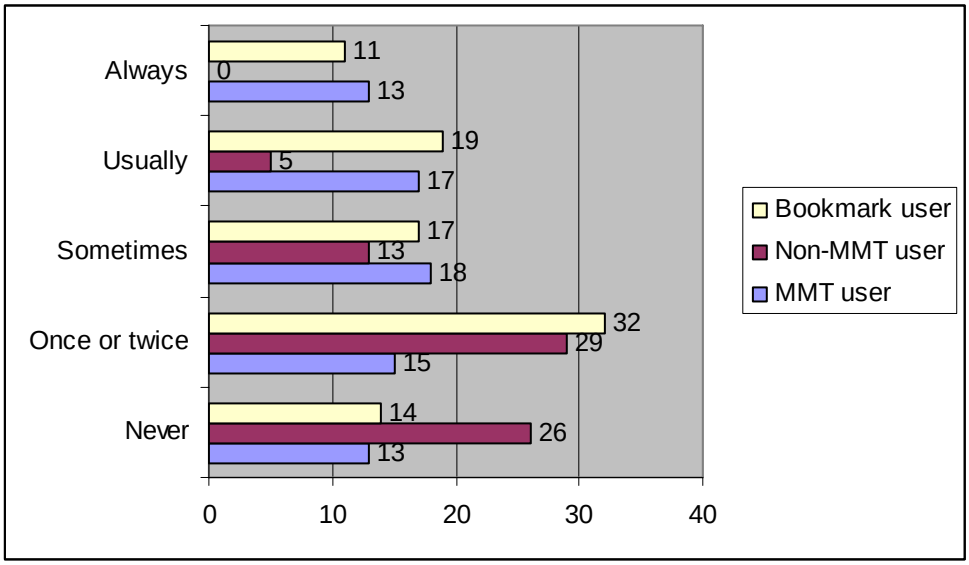
Gender among bookmark users was balanced, suggesting that although females were less likely to rent the Tour, they were more likely to answer an online survey or pick up their bookmarks than males. In the general exhibition visitors we interviewed, we found more female than male visitors contrary to the exhibition evaluator (Tisdal, 2006) and at a rate more similar to the institution's general visitor population (1999/2000 study).

2.2 MMT Users Have More Experience with and Interest in Audio Tours

MMT users were significantly more likely to voice interest (μ=7.0 out of 10.0) than non-MMT users (μ=4.6) in the idea of using a MMT for the rest of the Museum, $x^2(1, N=150)=34.6$, $p<.000$. As Figure 8 shows, individuals who used the MMT (including both the MMT exit

interviewees and bookmark survey respondents) reported using audio tours in museums significantly more frequently than non-MMT users, $x^2(4, N=243)=28.6$, $p<.000$.

FIGURE 8 Frequency of Tour Use in Other Museums



2.3 No Significant Differences in Other Demographic Categories by Group Type

As displayed in Table 2, no significant differences arose in age, group type and membership among visitor types. Exit interviewees tended to be 30-55 years old; bookmark survey respondents, perhaps since no age provisions were placed or perhaps because they are more apt to take an online survey, included slightly more children under 18. Most visitors interviewed were part of family groups on Fridays and Saturdays; this is different from the Getty Museum's experience where family groups with children were significantly more likely to rent than visitors with friends (Hart, 2005). Bookmark users tended to be members at a higher rate than the MMT and non MMT user.

TABLE 2 Age, Group Type and Membership by Visitor Type

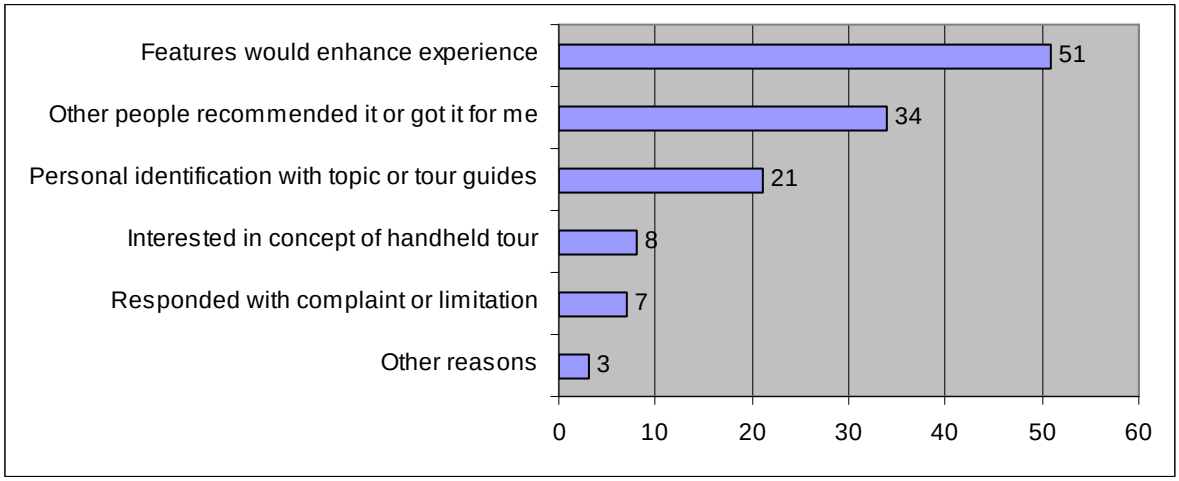
	MMT %	Non-MMT %	Bookmark %
AGE			
Under 18	14%	15%	20%
18-24	6%	11%	4%
25-29	17%	9%	4%
30-34	7%	15%	15%
35-44	22%	32%	27%
45-54	27%	16%	20%
55-64	6%	1%	5%
65+	1%	1%	1%
No response	0%	0%	2%
Total %	100%	100%	100%
N	72	75	92
GROUP TYPE			
Family	64%	70%	57%
Adults-only	37%	22%	30%
School group	0%	2%	2%
By self	0%	2%	6%
Other	0%	4%	6%
Total %	100%	100%	100%
N	73	76	91
MEMBER			
Yes	33%	32%	55%
No	66%	68%	45%
Total %	100%	100%	100%
N	73	75	94

2.4 Content, Curiosity and Positive Past Experiences with Audio Tours Reasons Among Why MMT Users Rented Tour

When asked what led to their decision to rent the MMT, we were able to tap into visitors' retrospective perceptions and expectations of the tour's value (see Figure 9). The MMT was most frequently associated with getting additional information (25 of 121 comments, or 21%) and bonus information, like *Behind the Scenes* (see Appendix for examples responses). The words "extra" and "add" were commonly used in responding to this question. Some visitors stressed how they needed to listen to information as they walked through the exhibition because they were weak readers (9 of 121 comments, or 9%). Other visitors described having positive experiences using audio tours in other museums or conversely, having passed up audio tours in other museums and regretting it (16 of 121 comments, or 13%).

Other factors that led to visitors renting the MMT included friends' feedback the on MMT, the website advertisement, visitor services staff's recommendations at the ticket counter and the pre-admission presentation (17 of 121 comments, or 9%). For other visitors, other group members had made the decision to rent the MMT for the interviewees (17 of 121 comments, or 9%).

FIGURE 9 Meta-Categories of Reasons Why Visitors Rented the MMT



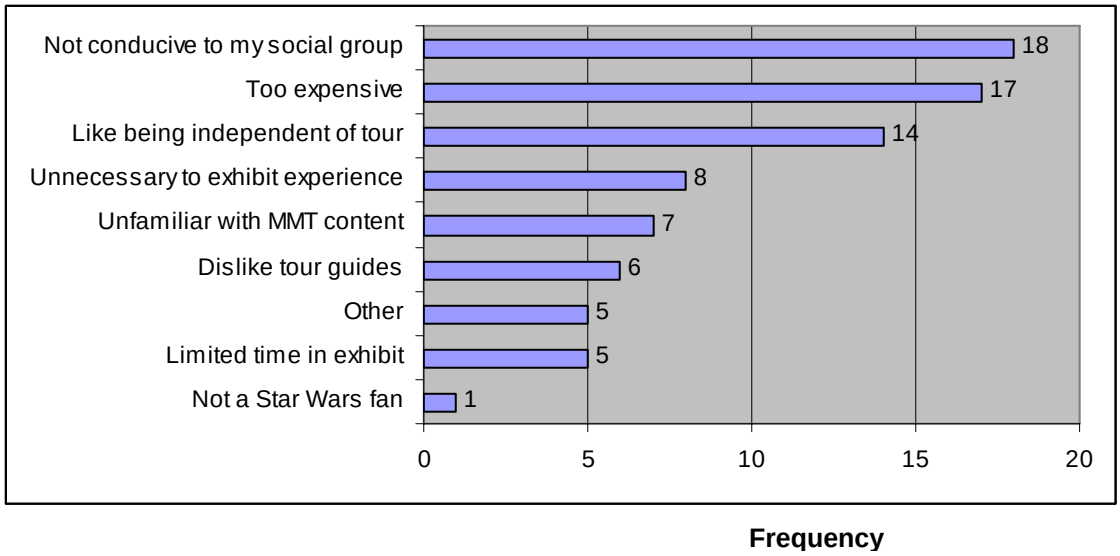
In response to this question, a minority of individuals voiced their dissatisfaction with the lack of distinct content on the Tour. Some complained that the Tour failed to highlight any differences between the exhibition and the handheld's content; the exhibition was already "self sufficient." One person thought that unlike art museums, there ended up being too much information on this handheld because the exhibit was already very informative and hands-on. Another person expressed disappointment because he previously thought he could ask the handheld questions and that it would answer.

2.5 Social Group, Price, and Desired Independent Experience Among Reasons Why Visitors Decided Not to Rent the Handheld

There were three major factors that led visitors to not rent the MMT: cost, desire for independence, and the needs of their social group (see Figure 10). From the visitor's point of view, the exhibit experience was already expensive with $20 a ticket for adult exhibition admission. Adding a Multimedia Tour for each group member would have been financially prohibitive: "We had 6 people, and if you rent for one you have to rent for all and that would be like $30 bucks" (#75). Also central to this person's statement is the idea that one belongs to a group which has inherent needs. Many people came as part of a group and did not want the Tour to interfere with their group social activity or could not allow it to, especially if they had young children they had to tend to: "[I'm] not interested because we're with our kids; we don't

have the leisure time to do that and watch kids" (#64). Moreover, in the exhibition, people liked having their own independence and not being tied down: "I don't like anything that controls my processing, of [my] taking in information. I'm one of those people who revisits just to look at one or two things" (#32).

FIGURE 10 Categories of Reasons Visitors Didn't Rent the MMT

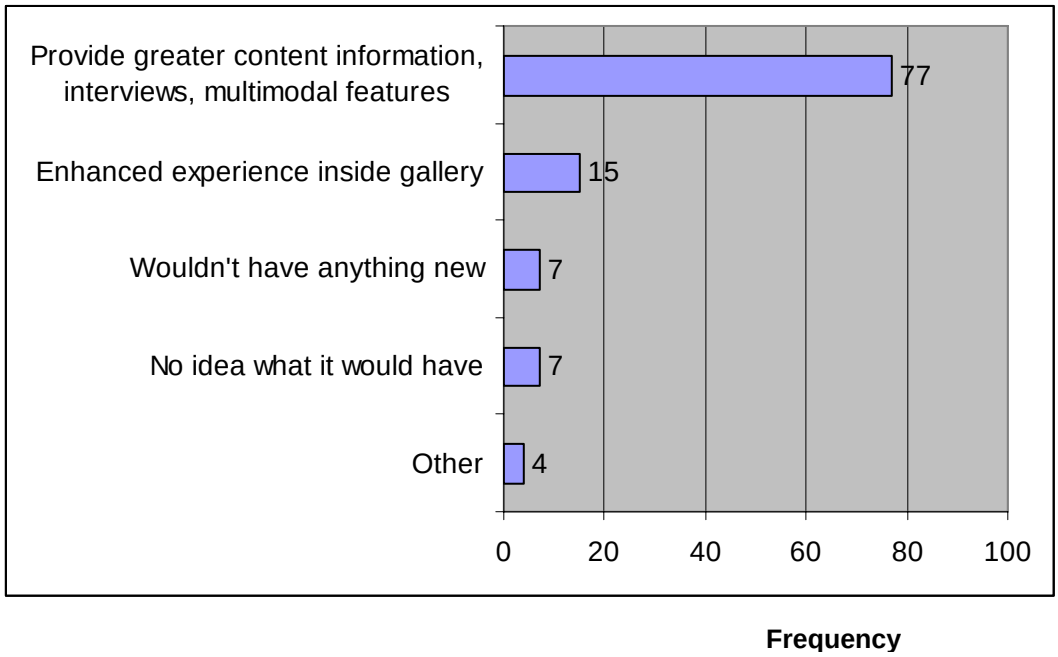


Another reason people did not get the handheld was because 15% of interviewees were unaware that a MMT guide existed (12 of 76 individuals). These responses were given even after the pre-show video was developed, in which the MMT was advertised in addition to the rules about the exhibition. Seven of those twelve individuals (59%) reported that had they known, they would have gotten a MMT Guide. One should keep in mind, however, that self-predictions of behaviors are known to be imprecise, this particular finding must be taken with a grain of salt.

2.6 General Visitors Imagined the MMT to Be Informative

Still, general visitors thought there would be more information on the MMT that would reinforce the *Star Wars* connection; further, they believed that it would empower visitors with a greater understanding of the exhibition. They thought it would also add detail that was not included in standalone exhibits (see Figure 11): "I guess maybe [it] explained what the exhibit is and how long it exists… [in the] past, future, or now" (#48). Visitors also expected some multimodal content, such as video and especially audio components. To a lesser degree, visitors anticipated it would be a tour, bringing users around the gallery.

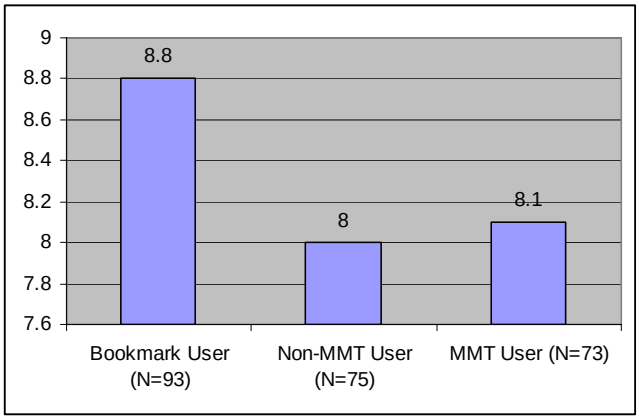
FIGURE 11 Meta-Categories of Visitors' Expectations of What MMT Has



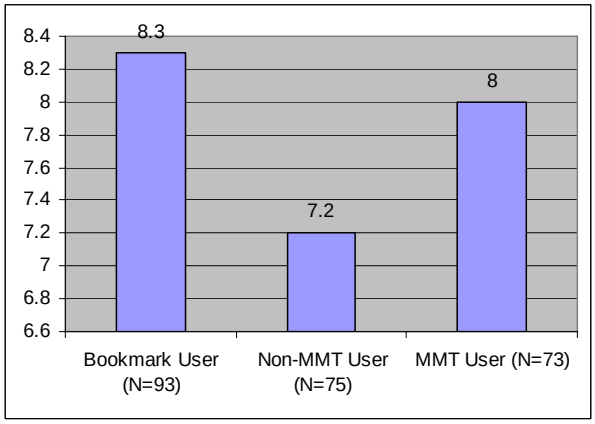
2.7 Bookmark Users Are a Dedicated Population

Compared to the MMT and non-MMT visitors, bookmark users had significantly higher interest levels in science, Mann Whitney U=5125.0, $p<.001$, visited the Museum's website more frequently, $x^2(8, N=233)=28.8$, $p<.000$, and visited the Museum of Science more recently, $x^2(8, N=242)=22.8$, $p<.000$. In contrast to the MMT and non-MMT user population, there were no first time visitors among bookmark users. They were slightly, but not significantly more likely to be members of the Museum**.** Bookmark users also rated themselves as greater *Star Wars* fans more than non-MMT users (see Figure 12), Mann Whitney U=2626.0, $p<.05$. MMT users were also greater *Star Wars* fans than non-MMT visitors. These findings suggest that the bookmark user, or alternatively, the bookmark users who elected to take the survey, were more dedicated to the MOS and the *Star Wars* topic.

FIGURE 12
Mean Interest in Science and Technology and *Star Wars* Fans by Group Type



Interest in Science and Technology



Self-Rating of *Star Wars* Fandom

*Note: Ratings were made on a scale from 1 to 10, with 10 having the greatest interest and 1 indicating no interest at all.

2.8 In Summary

Different groups of visitors emerged: visitors concerned with cost; visitors who desired an independent experience; visitors who wanted valued their social group experience in the exhibition; and stronger *Star Wars* fans who wanted a fuller exhibit experience. As the next section details, the expectation of MMT users to receive greater details from the handheld and their driving interest in *Star Wars* became most valued aspects of the Tour.

3. WHAT DO VISITORS PERCEIVE TO BE THE GREATEST VALUE OF THE MULTIMEDIA TOUR (MMT)?

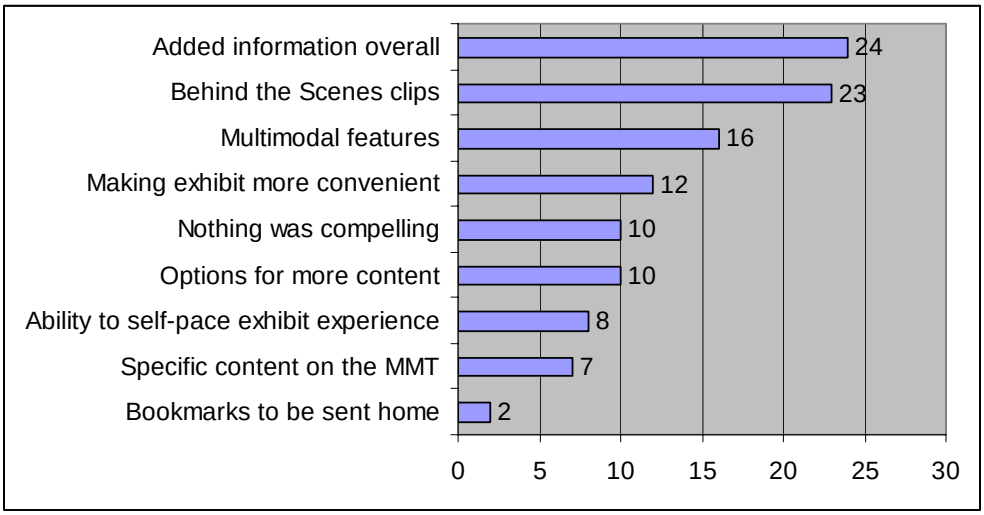
Overall, users reported high satisfaction with the MMT, with an average rating of 7.9 out of 10 and median of 8 out of 10. There was a small constituency that rated their satisfaction a 6 or lower (15 of 76 people or 20%), and most of these individuals reported they would not or were unsure if they would rented the MMT in retrospect (13 of 15 people or 87%).

3.1 Star Wars and Behind the Scenes *Content Most Compelling Aspect of MMT*

Just as general visitors had anticipated, MMT users really appreciated getting a more complete, knowledgeable experience of the exhibition (see Figure 13). When asked what they found to be most compelling, visitors spoke generally about the fact that the MMT gave more background information (24 of 113 comments, or 21%) and greater context than what the exhibition's label copy provided: "I liked the interviews because it gave you something past what was written down at each exhibit" (#12).

A significant number of interviewees targeted the *Behind the Scenes* content on the film's creation to be most compelling (23 of 113 comments, or 20%). Visitors really enjoyed the interviews with the film producers and staff that allowed them to gain insight on processes like the evolution of costumes and the source of sounds. For instance, one person enjoyed learning about "how they built [actual spaceship]… [and] about the trick photography" involved (#17).[3]

FIGURE 13 Categories of Compelling Aspects of the MMT



[3] The remaining categories of responses are detailed in the appendices.

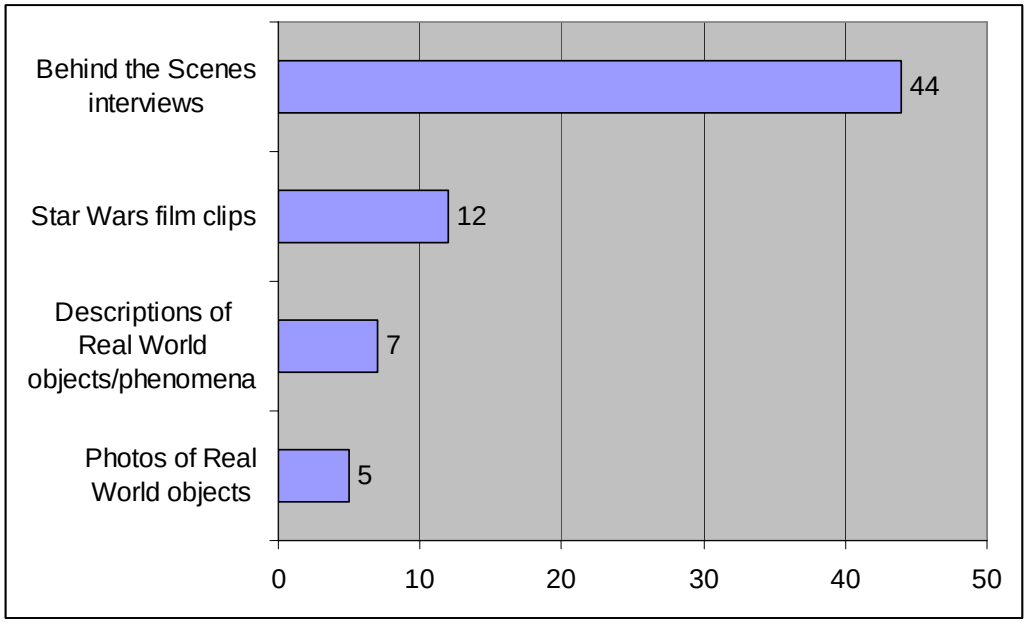
Other compelling aspects were the handheld's multimedia, like the video and images available for each stop. Many commented on how the video added that "extra" little aspect that they had not seen before in museum tour guides. Others appreciated being able to walk around while listening.

Additionally, visitors valued: a) the ability to select additional information, such as more descriptions and video, b) not being confined by a directed tour, but opting to choose when to use the MMT, and c) the ease with which they were able to use the technology. The MMT allowed them to not fight through the crowds and instead to find out more information if they so wanted: "if you didn't know [what the artifact was], just type it in" (#34). Furthermore, you "could choose the order… you could wander, go back, wander, go back, repeat, skip or stop… very versatile" (#22). The tour's design afforded visitors a sense of independence.

3.2 Visitors' Favorite Content on the MMT: Behind the Scenes

Visitors were asked which of the four major types of content on the MMT – the *Star Wars* film clips, *Behind the Scenes* interviews, descriptions of real world phenomena, and photos of real world objects – they enjoyed most. Not surprisingly, visitors' favorite MMT content was directly related to the *Star Wars* films (see Figure 14). When asked to elaborate on why the *Behind the Scenes* interviews was their favorite type of content, most visitors again described being curious about what the filmmakers were thinking as they were creating those scenes. Likewise, many wanted to find out more background information. Others said that this was their primary interest in coming to the exhibit in the first place, and that they identified personally with it professionally or personally as a fan of *Star Wars* since childhood.

FIGURE 14 MMT Visitors' Favorite Content



The MMT users' strong interest in *Behind the Scenes* could further illustrate the power of the personal back-story in resonating with people, which the Smithsonian Museum of Air and Space's handheld tour leverages. Arguably more *Star Wars* related information was presented on MMT than on the Real World (see Appendix). Had the real world phenomena and artifact stops had featured film clips and interviews with prominent engineers and inventors providing that firsthand story, it seems possible real world content would have triggered greater interest.

Despite the fact that the *Star Wars* film clips were few and brief, they were the second most popular category of content was the *Star Wars* film clips. This makes sense since more MMT visitors were devoted *Star Wars* fans, and thus the film clips were interesting and familiar to them. One person even equated the clips with his childhood. Most other visitors described themselves as enjoying the multisensory aspect: it's about "visual learning…other stuff was static…film clips tied [things] together nicely" and "because that's fun instead of listening to someone talk" (#34).

A small minority of individuals liked the descriptions of real world phenomena mainly because of the connection to the exhibits and to finding out about real technologies. Just five people listed photos of real world objects as their favorite content, perhaps because there were so few photos in the Tour. It is also interesting to note that a small percentage of individuals reported that they had not seen some content categories on the MMT, and thus chose a type of content based on default. This may be because the greatest amount of content on the MMT was *Behind the Scenes* and artifact narration. One category that was missing from the list was narration of *Star Wars* artifacts; while the inclusion of this category would have been telling and a more accurate account, one could assume that this is a subsection of the *Star Wars* content.

3.3 Visitors Dissatisfied with MMT's Repetitious Content

There was a strong minority of MMT users who expressed dissatisfaction or enumerated limitations of the MMT across responses. Similar to the visitors who voiced that their initial expectations of the Tour were unmet, a number of individuals reported that the MMT did not have any compelling aspects. Again some visitors felt that the Tour content was the same as the exhibition's , especially since the exhibition was already so multimedia-heavy, thus making the MMT unnecessary and cumbersome: "you focused either on the multimedia tour guide or held the thing up to your ear; I didn't do both. [It had] decent, basic information, but I don't think I'd rent it again; I'd read [labels] and use headphones" (#30). Interestingly, the headphones this person was referring to were hearphones, which describe the exhibit's layout and provides basic instructions based off the label instructions, and were originally designed them to make exhibits accessible. These hearphones do not provide interpretation, yet it is quite possible she placed value on them for affording a multisensory experience because she felt all of the content was already present in the hearphones.

When visitors were asked in the follow-up interviews if they felt content was significantly different than what was presented in the exhibition, most disagreed. However, most follow up

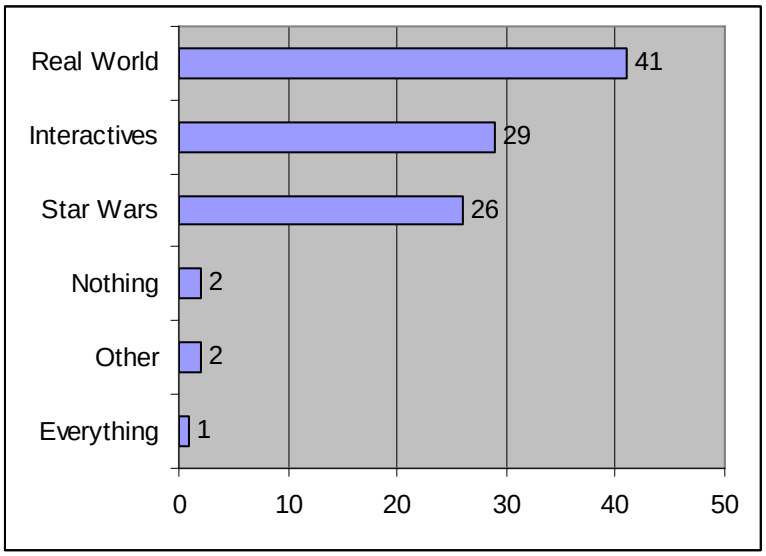
interviewees were not strongly discontent. People "[knew] it added" and extended what was presented, given it was "moderately different."

3.4 Non-MMT Users' Report Real World as Most Compelling Aspects of the Exhibition

In striking contrast to MMT visitors, when asked what they found most compelling in the exhibition, non-MMT visitors' responses were related to real world related content, interactives, and finally *Star Wars* related content. The overwhelming majority of interest lay in the real world robots, of "how robots would be used in the future" (#62), followed by transplants, and in particular prosthetics and bionics (see Figure 15). The maglev engineering design lab was the most compelling interactive: "Maglev makes you think about how you could apply that" (#28).

Visitors least frequently brought up the *Star Wars* costumes and artifacts as a compelling category and how the movies were made as being interesting: "The different way that they did [made] things, like how C 3PO was made; it showed you how they did it" (#21). While the questions we asked to the MMT and the non-MMT user differed in seeing what they found most compelling about the MMT or the exhibition, the strikingly different responses highlight the difference in visitors' focus, based on the content focus of the exhibition versus the MMT (see Appendix).

FIGURE 15 Meta-Categories of Most Compelling Aspects of Exhibit



3.5 In Summary

MMT visitors enjoyed that the Tour gave them information beyond the exhibition and valued the *Behind the Scenes* and *Star Wars* content the most. Building upon these findings, the next section of this report shows, not surprisingly, that MMT users appear to have more of a *Star Wars Behind the Scenes* educational experience than non-MMT users who tended to glean more real world information. To some degree, this finding may also be impacted by the gender bias since we interviewed more female non-MMT visitors and more male MMT visitors, as we know females tend to be more interested in health and the environment (Gyllenhaal, 2004; Chin, 2004; thus, the prosthetics section) and tend to be lesser *Star Wars* fans than males.

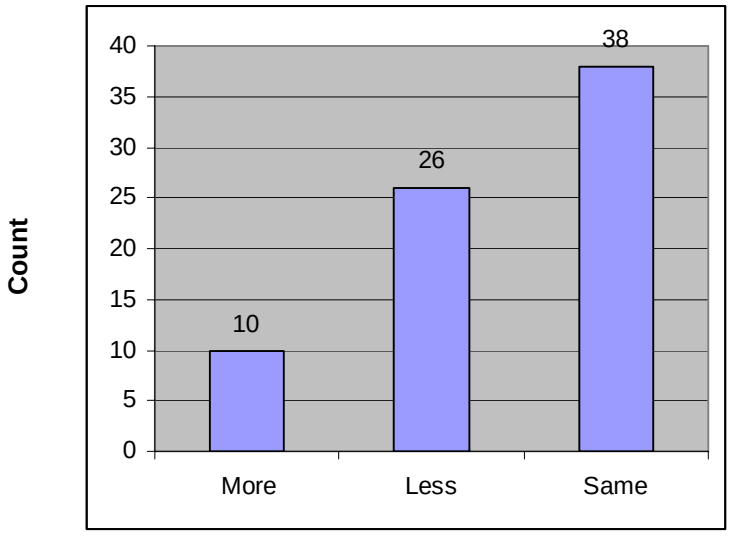
4. HOW IS THE *STAR WARS: WHERE SCIENCE MEETS IMAGINATION* EXPERIENCE DIFFERENT FOR USERS OF THE MULTIMEDIA TOUR AS COMPARED TO NON-USERS?

4.1 MMT Visitors Felt They Interacted with their Social Group at the Same Level Had they Not Rented Tour

On average, visitors reported a median visit of 15 MMT stops, with a range of visiting 2 to all 22 stops. The self-reported number, however, should be reconciled with previous literature and the case studies which place doubt on their accuracy.

A concern raised by other museums' guides was that social group interaction would decrease as a result of using the MMT. To measure visitors' perceptions, we asked if visitors felt they interacted more, less or the same with other members of their group because of the MMT. About a third of visitors thought they interacted less (see Figure 16). Yet nearly half of the interviewees reported interacting at the same level they would have had they not rented the MMT and 14% of visitors reported interacting more as a result of the Tour – perhaps because it gave additional content for group members to discuss. The steady number of people who felt they interacted at the same level suggests that people felt comfortable with their experience inside the exhibition as it related to their social group.

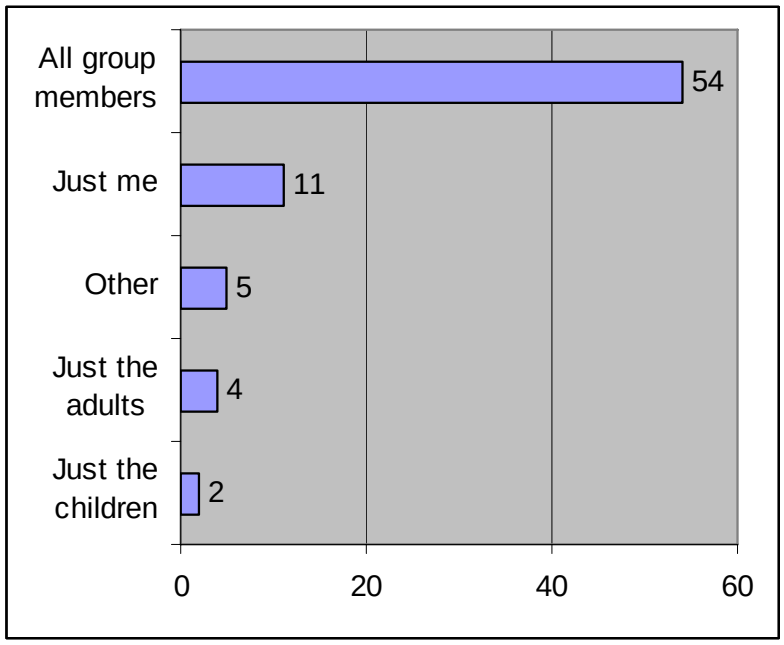
FIGURE 16 Visitors Report How the MMT Changed Social Group Interaction



As Figure 17 shows, it is also possible that the MMT did not imbalance the groups' social interaction because for a majority of the MMT interviewees, all group members used a MMT (71%). It could be interpreted that all members have their own MMT or share one with another group member. In comparison, there was only a small percentage of groups where

individual members used a MMT such as adults-only (5%), just the children (3%), and just one person in the group (14%).

FIGURE 17 Group Usage of the MMT



4.2 MMT Users Remember an Informative Tour that Made Exhibition Experience More Enjoyable, Informative and Longer

Six to 10 weeks after their visit, MMT and bookmark users reported remembering that the Tour was very informative and positive overall. Conversely, some comments were made about disappointment in the Tour, either in regard to the tour's neck lanyard being too long, a confusing stop order or repetitive content.

When asked how the MMT impacted their experience, if at all, MMT and bookmark users explained that the Tour enriched their experience. By listening to the Tour, users were forced to slow down. They absorbed greater information and heard other perspectives:

> *It provided me with other people's opinions and ideas about what we were seeing. I feel if I [had] just gone…, I would have seen what I already knew – I would have picked up some stuff about science behind exhibits, but I wouldn't have understood the place of [science] in the movies themselves [and how] a lot of science exploration now is going back to the movies now. So I think a lot of the interviews on the Tour prompted [that] (#75, MMT user).*

Hearing the perspectives of film producers and actor Anthony Daniels increased learning and made the experience more enjoyable for the visitors. Only one interviewee described that the Tour did not add much, but "just reinforced things." Bookmark users reported remembering *Behind the Scenes* information more frequently whereas MMT users reported remembering how easy it was to use.

4.3 Case Studies of MMT and Non-MMT Users Highlight Differences in Use of Interactives and Levels of Social Interaction

While half of interviewed MMT visitors reported that their social interactions were the same as if they not rented the MMT and 14% even thought that interacted more with the group, our case study observations tell a different story. Striking differences emerge in terms of visitors' use of interactive exhibits and social interaction.

Case study 1: Quiet MMT Couple Uses the Tour in Linear Fashion

It was a mildly quiet Friday afternoon and the *Star Wars* gallery had mostly family groups inside. A young European couple in their 20s entered the *Star Wars* gallery. The woman, Carolina, had been curious about the Multimedia Tour and decided to get her and her partner, Stefan, handhelds to accompany their visit. The day was Carolina's gift to Stefan since he is a huge *Star Wars* fan.

Much of their visit was characterized by the conception of tour guides being a linear experience and providing higher quality information than the rest of the exhibition. They spent their first hour in the exhibition strictly following MMT stops in order and consequently spent a surprisingly long amount of their time circling the gallery looking for the next stop. Most of their time was characterized as looking at the exhibits featured and listening to the Tour.

While Carolina is quick with a smile and very friendly, Stefan is quiet and tends not to say much. They did not say much to one another while they were listening to the tour or even after they have finished their Tour. However, their actions showed that they were very much doing the Tour together. They stood very close together; at times, Stefan would hold his Tour out so that Carolina could see what stop he was on. Stefan led their interactions, starting the next exhibit on the Tour before Carolina. Sometimes he would wait and return to Carolina if she was behind. Their explicit social interaction consisted of impromptu sign language, holding up fingers to indicate where the next exhibit was, or saying a popular phrase heard inside the gallery, "Where is #6?"

While they went to each Engineering Design Lab and touched the parts as they listened to the Tour stop, clearly taking the Tour's explanation into consideration, they only participated in two interactives – *Robot Vision*, where they spent a few minutes trying to trick the robot—and *Ride on a Cushion of Air*, which they did after finishing the Tour.

They did not watch any of the video exhibits as Carolina later explained that she had assumed the content wasn't as good as the Multimedia Tour's based on its cost and her past experiences with audio tours.

It was only after they finished all 22 stops on the Tour that they looked at or tried a couple of other exhibits like *Ride on a Cushion of Air, Robot Theater* and an interpreter cart on prosthetics. They looped around the exhibition one final time, holding hands, still not saying very much to one another, and decided to leave. They were satisfied with their visit and use of the Multimedia Tour in accessing additional knowledge about *Star Wars*, science and technology.

Case Study 2: Mom and Two Children Do MMT Together in Exhibition

Between the time the first and second case studies were conducted prototypes of larger MMT signs were placed in more prominent locations. The Hughes' experience inside the exhibition showed that these signs made a world of difference in that visitors no longer struggled to locate stops. Kay, 11, Jerry, 9 and their mom decided to come to the Museum on a Friday afternoon to see the *Star Wars* exhibition. When buying exhibition tickets from a kiosk, Mrs. Hughes accidentally purchased the MMT with their tickets under the assumption she was getting more information on the handheld. Once selecting it, however, she couldn't remove it from her shopping cart and subsequently, each member of their group ended up with their own MMT.

Once inside the gallery, the group took a few minutes to get started. Kay helped her mother understand the process of tapping in a number and Jerry explained that she could watch the video content on the screen. Like the previous couple, once in the exhibition, this group generally stayed together for the most part. Kay tended to stand very close to her mother and at times, watched what her mother entered into the handheld so that she could simultaneously enter the same number. The children were the leaders in this interaction, pointing out new stops (e.g., "Mom, #4's right there!"), and bringing the group over. In general, their behaviors resembled Stefan's in that they scanned the exhibit for the next stop in sight, walked over, entered the number, listened for a bit, and then walked around the gallery while listening. By the time they had watched 8 stops, the children were feeling a bit tired. After the first 8 stops, Kay and Mrs. Hughes let the handheld hang from their neck instead of holding it in their hands and watching.

Like Stefan and Carolina, this group's social interactions consisted of more *pointing* than talking. They pointed out MMT stops to one another and at times, pointed toward the screen and toward some exhibits. The level of conversation was very directional, concise and limited in nature, with comments like "Look at this" or "I want to look at something else" that did not reference the MMT content. One highlighted conversation was at *These Bots are Made for Walking*, when Kay's mom pointed to the Robo-Sapiens and said to her children, "Oh, you have that" and Kay replied "No, [Jerry] has a different one." The Hughes wore their headphones nearly the entire time they were in the exhibition.

Like the previous case study participants, the Hughes spent about 75 minutes in the exhibition and saw the *Robot Theater*. Generally they stuck to exhibits with the MMT stops, with the exception of the two interactives they used, *Dynamic Stability* and *Walking is Not Easy*. Interestingly, they, too, refrained from doing any of the *Engineering Design Labs*. Like Stefan and Carolina, for the most part they bypassed the videos that were part of the exhibits.

In reflection, Mrs. Hughes thought that they had "learned a lot more than we would have [without the MMT] because we don't have the patience to read [the labels]." Like many of the other MMT users we interviewed, Mrs. Hughes really liked being able to set her own pace and not follow a linear tour, which they were accustomed to with other tours . This group's self-pacing was contrary to Stefan and Carolina, who spent a painful amount of their time searching for the stops in order, thinking that they had some important, logical progression.

Case Study 3: Independent MMT Teenage User

Kera, 14 years old, came to the *Star Wars* exhibition with her father and grandfather on a Friday afternoon. Kera, being a moderate *Star Wars* fan, decided to get the MMT because she "wanted to be able to have a guide that would help [her] understand what [she] was looking at."

Unlike the Hughes, once inside the gallery, the group split up leaving Kera on her own. Even when her grandfather and her father joined her at an exhibit, they did not interact with one another and quickly separated again. In the first half of the gallery, their group did bump into another group of friends and waited for the *Robot Theater* together. During that time, Kera let a 5-year old listen to the MMT and instructed the child on how to use it.

As Kera moved through the gallery, her behaviors showed that she was a very diligent visitor as she watched the videos in the exhibits, read the labels and looked at the cases while listening to 14 of the 22 MMT stops, although she reported that she thought she had done nearly all of the stops. Whenever Kera happened to come upon an exhibit with a MMT stop, she would put her headphones on and listen; as soon as she finished, she would take them off. Kera watched some of the interviews with producers, but didn't bookmark information or realize what its functionality was.

Again, like the previous two case studies, Kera did not use the *Robot* or *Maglev Engineering Design Labs*. The only interactives she used were *Dynamic Stability* and *Moving Down the Skyway*, at which she spent a considerable amount of time and her father commented to the Research staff that, "She could spend hours doing Sims."

Like the other two groups, she watched *Robot Theater* and spent a total of 75 minutes in the gallery. Similar to many of the MMT exit interview findings, Kera thoroughly enjoyed the *Behind the Scenes* interviews and wished there were more.

This case study is very different in that Kera's experience was very independent from her group, perhaps because she is a young teenager. Yet already across the three MMT users, the pattern of skipping the interactives is striking.

Case Study 4: Non-MMT Adult Couple Who Don't Converse Much but Use Interactives

Josh, who is 34 and from the UK, and Lina, who is 30 and from Germany, have come to the Museum on a Friday afternoon. This is their first visit to the Museum of Science and neither don't consider themselves real *Star Wars* fans. The adult couples' interaction is strikingly different from many of the MMT users in their extensive use of interactives, but not incredibly different in their low level of conversation.

Josh and Lina were diligent visitors, moving from one side of the exhibit to the next, visiting nearly all of the exhibits including many interactives. At the behest of Lina, they watched nearly all of the exhibition's videos, and scrolled through each video as they stood next to one other often in silence. At times, they made lone comments to each other about the content. At *Real World Speeders*, for instance, Linda asked Josh an exhibit related question and Josh replied, "that's the most efficient height for flight." At other times, while Lina was thoroughly engrossed in the videos, Josh would sometimes wander off. Generally, they stayed together for most of the time.

Overall, they did not speak much, perhaps because the exhibit was media-heavy and Lina was thoroughly engrossed in the exhibit videos. However, this was not the case at the interactives. Unlike all of the MMT users, Josh and Lina did both of the EDLs together and did nearly half of the exhibition's interactives. They collaborated on the EDLs and some other interactives, showing deep engagement in trying three times to get the Robot EDL to work, and with each offering the other suggestions on how to succeed.

Josh and Lina spent 80 minutes in the gallery. While Josh was aware of the MMT tour, he hadn't wanted to spend extra money on one. For Josh, the *Robot EDL* was most compelling; for Lina, the videos were most interesting. She found the subtitling particularly helpful if she couldn't hear something properly.

While these adult visitors were not necessarily talking very much, already we see a much higher level of engagement, collaboration and interactivity than the non-MMT groups. These behaviors are also ones the exhibit developers might consider critical to understanding the exhibit and meeting its goals.

Case Study 5: Non-MMT Parents with Two Boys' Active Experience in Exhibition

Two parents, Mr. and Mrs. Rivers, and two children, Larry and Seth, both 8, came to the exhibition on a Friday afternoon. It is believed that Seth has some type of disability or behavioral disorder given his observed inability to stay still for a few minutes, unclear speech, and uncomfortable moments during which he had to be restrained by his parents.

This group's experience inside the gallery was substantially different before and after they are joined by a second family group. In the beginning of the exhibition visit, the parents provide a high amount of mediation of the exhibit, relating and explaining concepts to their boys. "They had a camera on something that could move [in order to film this]… See? You don't see the wheels, they erased them later" and "How'd you like to go to school that way?" When joined by the other family group, the parents split up and each adult takes a couple children. Much of their mediation then became directional in nature, trying to focus the boys' attention or move them to a certain exhibit.

In general, the boys exhibited great excitement in the gallery. The boys led the group to different exhibits in random fashion according to whatever looked cool to them. The boys thoroughly enjoyed *Ride a Cushion of Air*, taking advantage of a short line (although to such a degree that Larry had to be physically removed) while their parents watched the side panel video.

The group watched only a couple videos and like Josh and Lina, tried a good number of the interactives, including the *Ride a Cushion of Air, Robot EDL, Walking is Not Easy,* and *Robot Vision.* The two family groups also watched *Robot Theater*, with the boys talking in line about aliens with a MOS staff member and the parents chatting about their visit to the Butterfly Garden.

In total, the group spent 75 minutes in the gallery and were very tired afterwards; they did not have time to debrief with our observer. Compared to the other observations, this group certainly had a different energy accompanying it, in part due to the presence of younger children and perhaps a great deal of mediation was needed by parents, especially because one of the children seemed to have a disorder or disability. Undeniably, we observed a great deal of use of the interactives, group conversation relating to exhibits, and behaviors indicating open enjoyment and engagement.

Case Study 6: Non-MMT Family's Active Experience in the Exhibition

The Lewis parents have brought their children, Polly, 13, Rene, 10 and Max, 6 to the exhibition. The two youngest children are big fans of *Star Wars*. On this late Friday afternoon, it was relatively empty in the exhibition, more so than for the other observed groups.

Perhaps in part due to the empty exhibition, unlike the other case studies, the Lewises zigzagged through the exhibit twice, spending considerable time at the two *EDLs, Ride*

on a Cushion of Air, and 3-D game *Building Communities*. Max was drawn to the costumes and watching the exhibit's videos while Polly, a teenager, was torn between being on her own and being with her family. A member of their group tried nearly every interactive. Their family took many photos with the *Star Wars* characters and talked about whether or not these costumes were real and how they were used. Overall, they watched only a few video clips.

Like Seth and Larry's parents, this family's interaction in the exhibition was mediated, only to a greater degree and throughout the entire exhibit. The parents' comments were often encouraging and directional (e.g., "Turn it all the way…all the way!" or "You've got too much consumption…"), logistical (e.g., "Where's your brother?") and positive (e.g., "Cool!") in nature.

The Lewises spent a total of 60 minutes in the exhibit, the shortest amount of all six observed groups. In reflecting upon the exhibition experience, Polly voiced that she really liked being able to see the "real things" from the movies. They didn't get the MMT because as Polly said, "My mom didn't' want to. I was happier not to have the MMT because I want to see what I want, not what the tour tells you to. I think it's more enjoyable if you do it on your own."

The observed non-MMT case studies were progressively more social. Each of these non-MMT cases had group members exhibit some type of mediation or dialogue that often accompanied doing an interactive.

4.3.1 Commentary on Case Studies

In the first two MMT observations, we saw group members move together as a unit, yet interact very little. The Tour mediated which exhibits these groups went to and in a sense, limited the number of interactives they use. It is interesting that Kay wanted to share the experience with her mother by manually keeping their tours in synch. Like Stefan, the family groups listened as they moved through the gallery, gaining other stimulation. Kera, on the other hand, was a more thorough visitor, using MMT stops and exhibit videos and seemed to have gone into the gallery expecting a largely independent experience. It appears these groups fell into a habit of not conversing much. All three observed groups were characteristic of the many MMT users we interviewed in that they reported that they liked getting access to additional information. By using a range of 8 to all 22 stops, these visitors' behaviors indicated that they felt the content was worth listening to; furthermore, for two of the three observed MMT groups, the Tour became their primary the source of information and learning.

In the last two non-MMT observations, we saw the parents mediating the exhibit experience and reinforcing the exhibition's content. Across these three non-MMT cases, we also observed the freer use of and deep engagement in interactives and other exhibits – and simultaneously, greater encouragement and collaboration among group members.

All together, interesting trends emerged from the six case studies. We observed the three MMT user groups to have spoken little and used a limited number of the 11 interactives in the gallery. Unlike the general gallery visitors, we did not see as much discussion of exhibit content, engagement in the engineering design process, collaboration in efforts to solve problems together and the providing of encouragement during these uses of interactives. Unlike Tisdal's (2006) focused observation of a deaf man who used the ASL MMT and attended the exhibition with his hearing wife, there was no sharing of MMT content or natural prompting for discussion it caused.

Visitor groups, in which each individual member got a MMT, tended to stay together. Due to the lack of synching, we often saw people motioning and using sign language to communicate because one person would be still listening to a section when the other had stopped, and also because most visitors kept their headphones on the entire time. It took extra motivation and patience of a small minority of visitors like Kay to manually synch her player to her mother's so they could experience the exhibit and the same content together.

Overall, the level of conversation was higher in family groups than adult couples we observed. Certainly, each group's dynamic was different in part based on the children's age. Having the 6-year old Max might have evoked different behaviors from the family group members than having just Polly and Rene, who were about the same ages as Kay and Jerry. The teenagers, Polly and Kera, exhibited their independence to varying degrees, being off on their own.

4.4 During the Follow-Up Interviews, Non-MMT Users Report Remembering More Interactives from Exhibition than Visitors who Used the MMT

Based upon the observation that MMT visitors were less likely to use interactives, it is not surprising that MMT users had different types of memories of the exhibition six to 10 weeks later. In their follow-up interviews, non-MMT visitors were equally as likely to describe remembering interactives like the maglev EDLs in the exhibition as *Star Wars* artifacts like costumes and models. MMT and bookmark users, however, described remembering *Star Wars* artifacts twice as often as MMT users, perhaps reflecting the saliency these artifacts had on their memory or their exhibition experience.

Interestingly, non-MMT visitors recalled their experience more frequently in the lens of their children's experience. This is fitting given non-MMT visitors often cited their social group and young children as reasons why they did not rent the Tour:

> *You had a bunch of hands-on exhibits that were kind of cute. That left the most lasting impression… I thought it was very nice, something [the] kids could monkey around with. [I have a] 4-year-old and a 7-year-old, and it kind of brightened them up. [I had] wondered if they were [just] oohing and aahing, [like they did with] the memorabilia, but they got involved in it. Made it worthwhile for me as a parent (non-MMT, #58).*

4.5 In Summary

Based on case study observations, general non-MMT visitors to the exhibition used many interactives, showed deep engagement in them, and overall had a more open and social experience, frequenting various exhibits and talking to their group members. While MMT exit interviewees reported that the Tour did not change their level of social interaction, the MMT case studies told a different story. MMT visitors were found to be using few interactives and for two of the three MMT groups, the MMT served as these visitors' primary exhibit experience and source of information. As a result of these two different types of experiences, the next section explores how visitor learning was influenced.

5. HOW DO VISITORS INTEGRATE THE MULTIMEDIA TOUR INTO THEIR *LEARNING* EXPERIENCE IN THE MUSEUM AND AT HOME?

5.1 In the Exhibition, MMT Users Reported Learning about How the Film was Made from the Tour

Corresponding with reports of their favorite content and the most compelling aspects of the Tour, much of the MMT users' self-reported learning from the MMT related to how the film was developed (40 of 88 comments, or 45%). For example, visitors reported gaining an understanding of how costumes were selected and special effects achieved. It is noteworthy to see the level of detail visitors could use in describing their learning to us demonstrating their retention of MMT information. For example, many recalled how the mirrors were used to reflect the sand off of the landspeeder (#11) and it was a souped up English car that George Lucas liked to play around with (#18), that the Millenium Falcon was not the original one used (#53), and how the design of Darth Vader's mask was accidental (#18). Other specific facts were cited, like how "basketball players [were] inside the Wookiees" (#37).

While many visitors said that they did not learn anything (14 of 88, or 16%), some visitors argued that they learned a lot in general but couldn't specifically recount what (7 of 88 visitors, or 8%). Other visitors described learning facts about *Star Wars* in general (7 of 88 comments, or 8%).

5.2 After the Exhibition, Many MMT and Bookmark Users Could Not Describe Specific Learning from Tour

At least six weeks after their visit, many of the users had difficulty articulating what they had learned specifically from the Multimedia Tour, perhaps because the Tour was integrated into their overall experience and because the Tour's content was not completely distinct from the exhibit content. Many said the Tour generally provided more in-depth information and facts about how the film was made:

> *Oh, yeah, gosh, I don't remember. I remember - there being quite a bit of in-depth facts that you wouldn't have learned about it. [You could] sit around dinner [and say], 'Yoda was x,' and some of what Lucas was trying to imitate, or what their inspirations were, or why they decided to make this part of the Millennium Falcon do this, because in reality some device or would be required. (Bookmark user, #34)*

A few comments were made about specific learning of lightsabers, robots, environments and how R2D2's sounds were created.

When visitors were prompted, the follow-up interviews showed that the Tour indeed gave access to additional information that general non-MMT visitors did not receive. When asked specifically about what they remembered learning about Darth Vader and the lightsabers, two

stops in which the exhibit provided very little label copy and no accompanying video exhibit, bookmark users were more likely to report learning additional facts about Darth Vader's character development with his costume and voice and that the lightsaber was powered more by plasma than non-MMT and general MMT users:

> *That was interesting. I had never seen that before. [It was] interesting to hear some of the history about it; interesting to hear that nobody ever figured out what they were: not lasers, might have been plasma, plus it was all subjective. [It was] neat to see all the different light sabers. (MMT user, #59)*

It may be that the bookmarks reinforced the retention of content as Darth Vader was one of the most popular bookmarks sent home.

The above findings do not refute the non-MMT visitors' meaningful experiences at these particular exhibits. For example, a few parents had worthy discussions with their children at the lightsaber exhibit: "[my son] had a whole different idea of about how these worked… and wanted to know, 'Why doesn't mine work that way?' He has three [toy lightsabers] at home. The whole concept of light [as part of a weapon] was really good [for him to see]" (Non-MMT user, #24). Another non-MMT visitor described trying to guess which lightsabers belonged to whom. It should be noted that many people across all three groups didn't stop by or had forgotten these particular exhibits, although this was not the case with MMT visitors as much.

5.3 After the Exhibition, Visitors Across Groups Generally Expressed Learning Similar Things

There were many common themes among bookmark, MMT and non-MMT users' responses about what they learned from the general exhibition more than six weeks later. Visitors reported learning about technology and science from the real world, typically as they related to robotic, transportation and medicinal developments in technology: "I was interested in the medical aspect of it. You had one of the shows there on medical parts, futuristic [medicine], [and it was] pretty interesting. What [have] I learned from it? [There's] new technology out there; they will be using the stuff" (Non-MMT user, #38).

Second, visitors also reported finding out about what producers were thinking as the film was being shot: "I guess I liked getting the back stories on the characters, of what their costumes were made of, [and seeing them] up close and personal" (Bookmark user, #63). Third, a group of visitors reported learning about the relationship between the real world and the *Star Wars* technologies: "I liked the way they indicated that futuristic concepts that were used in the movie have actually come to life and have been added or transferred in ways. For example, [in the] robot show, there were similar robots… that go to robots today" (MMT user, #15). Last, a group of visitors who declared themselves very knowledgeable in *Star Wars* or with science, reported not learning any new concepts: "Well to be honest I am an engineer, and I was already [knowledgable]" (Bookmark user, #35).

While visitors from all three groups reported learning that originated from watching *Star Wars* and real world related videos and artifacts, non-MMT users were slightly more likely to describe learning that directly resulted from using an interactive than MMT and bookmark users.

5.4 In the Exhibition, MMT Visitors' Hardly Bookmarked; Bookmarks' Value Unclear

When asked whether or not they bookmarked information to be sent home to them, 16% of MMT visitors reported that they had. This number is slightly higher than the 10% bookmarking rate Antenna Audio captured for all visitors from the exhibition's opening to closing (3,333 of 33,052 users bookmarked). In contrast, 84% (or 63 of 75) individuals reported that they had not bookmarked and 23% (13 of 57) of those individuals said that they had not been familiar with option.

Individuals who were aware of the feature but chose not to bookmark often gave a general response that they had forgotten about the feature or didn't know why they would do so (10 of 58 comments, or 19%). Others often said that they were simply not interested in receiving any additional information and felt their time in the exhibit was sufficient (5 of 58 comments, or 9%). Some MMT users were limited by the fact that they were in the exhibition with others and were participating in a group experience and didn't have time to bookmark (5 of 58 comments, or 9%). A few other visitors said they don't like receiving e-mails and that they don't have time to look at them (4 of 48 comments, or 7%). People said that if they were more interested in the topic, knew what would be sent, were going to do additional research, or perhaps had more time, only then might they have bookmarked information to send home.

Of the few comments we received about why they bookmarked, visitors explained that they wanted to try it out (4 of 8 comments, or 50%). One person said he was "Interested to see what they would send [and] see how the Museum of Science would send [it]" (#48). Two people (25%) said they were *Star Wars* fans and wanted to see their favorite characters, while individual comments were made about wanting to send the information to one's brother and to use it in the classroom as a teacher. Visitors reported largely bookmarking *Star Wars* related content (8 of 12 comments, or 66%), such as the "speeder one, guns/lightsabers; Wookiees [and the] Millenium Falcon" (#22).

5.5 At Home: Visitors Are Reminded of Exhibition, but Rarely Follow Up on Active Learning

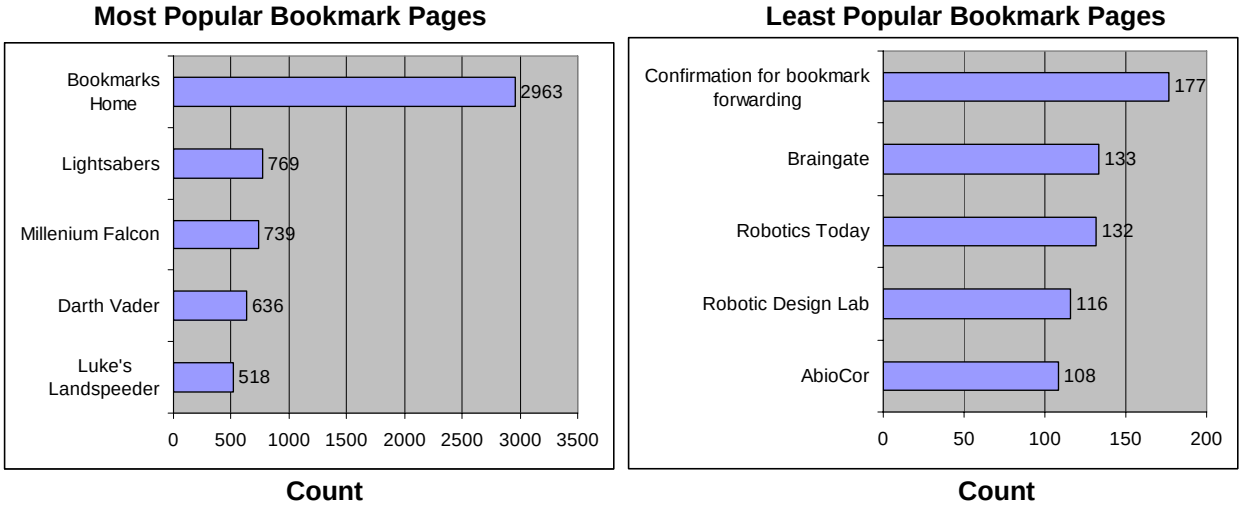
After their visit, most MMT, bookmark and non-MMT users had a conversation with friends, coworkers and others about the exhibition. Some visitors were reminded through their children's toys or seeing ads in the newspaper or the Mass Pike highway billboard about the exhibit experience. Some other visitors came across information in bookstores, newspapers, magazines or television on robotics that prompted them to think more deeply about the topic: "You know… they were talking about using [the maglev trains] in Japan, [and] Amtrak [is considering them as a] potential option [to be more] cost-effective. I think that was on Fox news" (MMT user, #75). For the most part, however, the majority of non-MMT, MMT and

bookmark users were not compelled to actively follow up on their learning beyond bookmark users picking up the electronic bookmarks. A couple of visitors came back to the Museum gift store and a few visitors re-watched the *Star Wars* films. The two children we talked to referred to thinking of the exhibition when they played *Star Wars* related videogames. One visitor attended a *Star Wars* lecture and another visitor, who was already a web surfer and *Star Wars* aficionado, visited blogs and websites about the film.

5.6 At Home: Bookmark Pick-up Statistics

Of the visitors who bookmarked and received a personalized link in their email inbox, 37% had clicked the link by May 30, 2006. Overall, there were 1,236 unique visitors to the bookmark URL homepage and a total of 10,707 hits to bookmark pages. This number does not represent staff, press, educators and other special groups that were given a separate URL. Visitors bookmarked a median of 7 stops to be sent home, though the average was higher at 9. They spent a total median time of 3 minutes, and average of 7 minutes looking at bookmarks.[4] The statistics show that 14% of individuals who picked up their bookmarks forwarded them to a friend. The most popular bookmarks were *Star Wars* related and the least popular were real world related, again attesting to higher interest among MMT users in *Star Wars* than the real world content (see Figure 18).

FIGURE 18

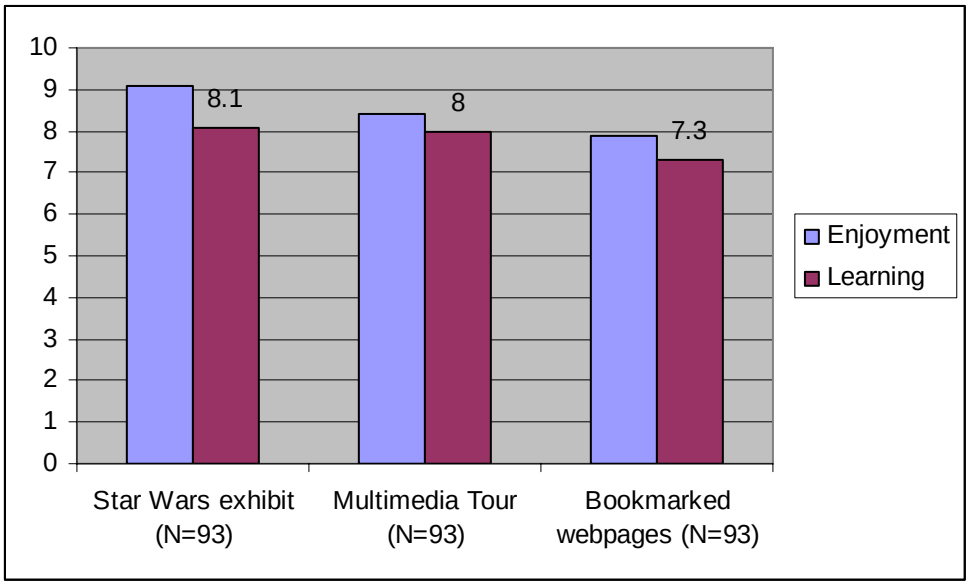


[4] These times are a compilation of all visits to the bookmarked pages, taking into the account that visitors tended to follow through a link upon receiving it and then immediately close it, opting to return for more information later. This total time does not include time spent on the last page of the bookmark URL they visited. Due to these standard web statistics caveats, reported times must allow room for error.

5.7 At Home: Bookmark Users' Had Lower Enjoyment of Bookmark Content Compared to MMT and Exhibition

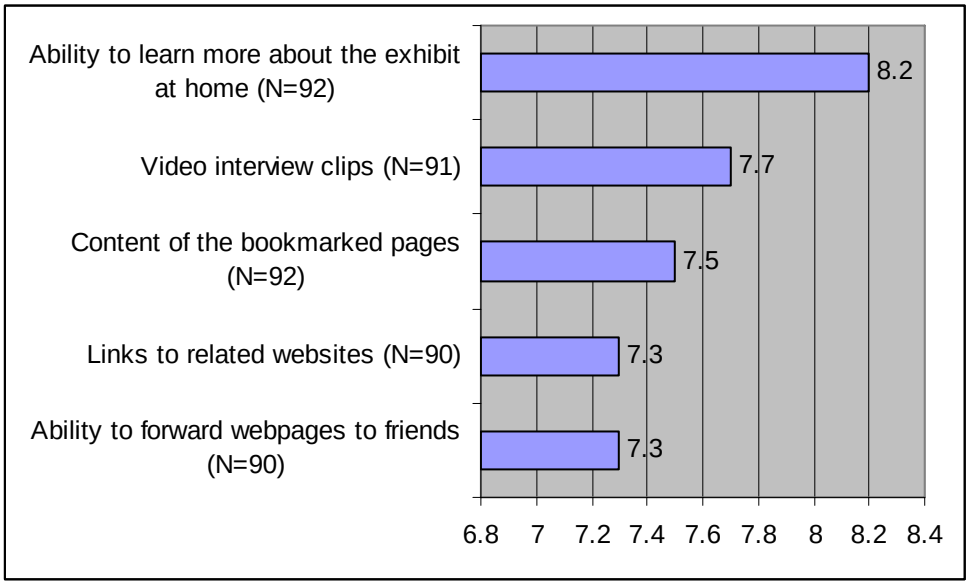
Interestingly, visitors rated the exhibition as providing the greatest amount of learning and enjoyment, followed by the MMT and lastly, the bookmarked webpages. This might reflect the fewer content and lesser immersive experiences the bookmarks offered (see Figure 19). It might also relate to the corresponding importance each carried – many came to the Museum to see the exhibition and had not planned on using the MMT; even fewer had known about the bookmarking feature.

FIGURE 19 Bookmark Users' Ratings of Enjoyment and Learning of Exhibition Components



When asked to rate multiple features of the bookmarked pages, visitors reported most liking the ability to learn more from their home (see Figure 20). They enjoyed the video interview clips slightly more than the written content of the bookmarked pages, perhaps because that content was distinct and did not require extensive reading as some individuals in the follow-up interviews had suggested. Most survey respondents did not find the ability to forward the website to friends very helpful which is not surprising given the low percentage of visitors who took advantage of this feature.

FIGURE 20 Visitor Ratings of Bookmark Features



*Note: Scales were on a scale from 1 to 10, with 1 representing least helpful and 10 representing most helpful.

5.8 Follow-Up Interviews Find Bookmarks Were Used and Valued in Several Ways

While bookmark respondents had rated the links to relate websites as not a very helpful feature, nearly all bookmark users later interviewed had reported looking at the additional links featured on certain bookmark pages. For the most part, MMT and bookmark users described doing different things with their bookmarks in the follow-up interviews. Some looked at them for a short amount of time "10 or 15 minutes... [on] just one or two. Did explore some of the links" (MMT user, #14). One other individual and her husband shared their individually received bookmarks with each other; another visitor "pulled apart the query string so I could get all bookmarks" (Bookmark user, #37) and another person used them "mostly as a jumping point to explore other *Star Wars* items on the Internet… Mostly fan websites" (Bookmark user, #35).

Bookmark users liked the novel idea of sending information home: "Time is so precious, I like going to the exhibit and linking to it later" (MMT user, #14). Many bookmark users also appreciated that it was a two part visit that "rounded out the visit very nicely" (Bookmark user, #38). One visitor in particular really liked the easy interface of receiving personalized content in email form.

On the other hand, visitors least liked the fact that they did not have access to all of the bookmarks. One person found them to be repetitive, "a retelling of information that was there at the exhibit or through the Multimedia Tour Guide" (Bookmark user, #35). Another person wanted them to be "more elaborate; more interactive; less encyclopedia like" (Bookmark user, #75) and described a loss of interest upon seeing them.

5.9 Paper Bookmarking Ad-Hoc Study

Taking the bookmark findings in stride, the Research/Evaluation team wondered about the effectiveness of making all bookmarks available to the general visitors. Previous research had found that museum visitors often use websites to plan a visit and follow up on interesting things they had seen (Sarraf, 1999). Would web traffic increase if visitor services staff handed out paper copies of a web URL? Would MMT users prefer not having to bother with manually bookmarking information to be sent home and instead going to a generic website with all 22 bookmarks? Would general exhibition visitors also be interested in accessing the bookmarks?

On Sunday, April 23, Antenna Audio distributed 377 paper bookmarks to all MMT users (with URL www.mos.org/SWbookmarksPDA) and *Star Wars* Visitor Services staff distributed 902 paper bookmarks (with URL www.mos.org/SWbookmarks) to visitors by *Robot Theater*.[5] These bookmarks featured the *Star Wars: Where Science Meets Imagination* logo at top, the URL along the body of the paper (with web address corresponding to being a general visitor or handheld user), and at the bottom, the message: "Visit www.mos.org/SWbookmarks to continue your *Star Wars: Where Science Meets Imagination* experience. Our new online bookmarks have additional information on many of the exhibits you saw today."

The Web Team was unable to track truly unique users based on the generic bookmark URL distributed.[6] The analysis is further complicated by the fact that Antenna Audio's bookmarking system had been backlogged and around the same time, was sending out hundreds of overdue bookmarks; thus, the overall number web hits at the time to the bookmark pages was inflated and findings must be taken lightly. Thirty five IP addresses were recorded from the general visitor population and 11 from Tour users. Overall, on April 23, the day the paper bookmarks were distributed, the online bookmarks website had a total of 171 hits across pages, of which 102 of the hits originated from visitors who had received a paper bookmark (60%). This paper bookmark group continued to visit the websites continually up to May 30, when the analysis was conducted.

Generally, it appears that the paper bookmarks had some positive impact on visitorship to the website and also had return visits by visitors, their friends, or family members. It may be worthwhile making even more content available on the web to get increased web hits overall and perhaps providing pamphlets or advertisements with reminders to follow up visits.

[5] There was a total of 3,667 visitors to the exhibition on this day.
[6] Unlike what happens when bookmarking with the handheld, no personalized URL was created for each Tour user; only IP addresses were measured in this ad hoc study, which does not account for the fact that many users have service providers like AOL that provide IP addresses of hundreds of customers.

5.10 In Summary

The bookmarking population turned out to be a small group of individuals among visitors who rented the MMT (10%). An even smaller group of the individuals who bookmarked (37%) ended up picking up their bookmarks. Visitors' comments of disappointment toward the bookmarks' content indicate the bookmarks should also be interactive and full of unique content. The following final section details specific recommendations MMT and non-MMT visitors gave on how to improve the MMT.

6. WHAT SUGGESTIONS DO VISITORS HAVE FOR FUTURE IMPLEMENTATIONS OF THIS TYPE OF TOUR?

6.1 MMT User Suggestions to Improve MMT are Sign and Content-Related

Nearly a quarter of MMT users did not have any suggestions on how to improve the MMT (19 of 83 comments, or 23%).

Of the suggestions made, many address the most common difficulties visitors encountered in using the handheld. For instance, visitors suggested improving Tour stop signage (10 of 83 comments, or 12%). Another major suggestion related to content (13 of 83 comments, or 16%). Visitors really wanted information that was truly distinct from what exhibits provided: "Make really distinct content from the exhibit content. If the PDA truly had extra content on it I would have spent even more on it" (#22). Even more *Behind the Scenes* content was requested: "More *Behind the Scenes*, the 'why?' …why did they design it, what was it like in the costumes, more George Lucas or actors talking… what choices they had to make" (#20). Finally, visitors requested changes based on personal interest, like offering more specific content on topics like space and a handheld that was personalized to specific age ranges: "Different content for different target audiences. A option for adults and one for kids at the different stations" (#29).

Some other comments were made on improving access to instructions either through a better orientation by Antenna Audio or a pamphlet (6 of 83 comments, or 7%). An improved version of the MMT would also have an interface that is easier to navigate and headphones that were less cumbersome, with either a belt clip option or headphones that fit users better (5 of 83 comments, or 6%).

6.2 Deaf Focus Group Suggestions to Improve MMT

From the focus group's findings, there emerged a clear set of immediate recommendations for the exhibition project team and a set of design recommendations for future handhelds:

Exhibition-Based Recommendations

1. Prominently market the handheld with the ASL and closed captioning symbol and the exhibition with the open captioning symbol. This should become standard procedure in all qualified marketing materials. This includes newspaper advertisements, website features and signage outside the exhibit and should also include handing out flyers or e-mail postcards to local deaf community groups and providing some complimentary tickets. The ASL Tour should also be featured at deaf expositions.

2. Improve stop signage both inside and outside the exhibition. Create larger multimedia tour signs at each tour stop, especially for those with low vision. (Note: This

recommendation was implemented in April 2006 and as second and third MMT case studies found, decreased the search for exhibit stops dramatically.)

Handheld Design Recommendations to the Field

- Continue to prototype and conduct focus groups with deaf users before making such handheld multimedia tours public so that the handheld's design, content and advertising can be better tailored to user needs and preferences. Had funds and time not been an issue and the focus groups been conducted before the handheld's final production, many of these recommendations could have been incorporated into the current version of the ASL Tour.

- Implement an instructional ASL video at the Antenna front desk: "if no distribution staff know sign language, consider play[ing] a signed video at the distribution desk to instruct deaf visitors in the use of the tour" (Proctor, 2002, p.5). This video could both be easily accessed for individuals needing help on how to use the device and dually serve as an advertisement to the deaf.

- Simulate going through the exhibition only using the ASL or text versions of tours to gain a better understanding of the timing effect. Also, include individuals who are deaf in the planning process.

- Continue to display short messages on the Tour with a greater emphasis on visual aspects. Consider ways to integrate the exhibit into the handheld through imagery.

- Have a larger interpreter image, focusing on the waist up.

- Experiment with more text captioning options, including the ability to read larger chunks at a time.

- Create a small pamphlet with an outline of each stop's content.

- Use a keyboard, not a T9 keypad.

A re-imagined ASL Multimedia Tour would still provide background information on the artifacts and have *Behind the Scenes* information. However, the handheld would be based on a Blackberry type device with a keypad or connect to a computer with a keyboard. It might take a step back and have some translation of label text and interpretation of exhibit components; it might even encourage greater interaction and thought by posing questions for consideration. This handheld would show the artifacts in the exhibition in motion and creation. In addition to visually displaying the artifact briefly on the screen, it might visually represent the spoken content through animation. Users could quickly reference an outline of content information to pick and choose from, either on the handheld or from a pamphlet. Like the Getty Museum's handheld, visitors would be able to navigate handheld content by selecting images as opposed to entering numbers and presumably enjoy this process (Hart, 2005).

6.3 Changes Need to be Made for Non-MMT Visitors to Use MMT

According to visitors who did not rent the tour, the Tour would have to be free, have information that was truly additional and enhancing to the exhibit, be conducive to a visitor that comes in a group (8 of 95 comments, or 8%), be interactive (8 of 95 comments, or 8%), easy to use (10 of 95 comments, or 11%) and allow their hands to be free to explore the gallery (8 of 95 comments, or 8%) in order for them to rent the Tour. For a couple visitors, MMTs are useful only if they provide access to content they are otherwise completely unfamiliar with (2 of 95 comments, or 2%): "We've rented them in the past -- my family [is more] willing to rent if [the] topic is one where we don't know anything about [it]" (#42). Advertising also needs to clearly outline what users would gain from the Tour (7 of 95 comments, or 7%): Give me a list of what it will tell me about. Tell me what I'm going to learn about up-front; promote what the content is up-front. For example, ask 'Do you want to learn about levitation? Then rent this tour. Or [do you] want to learn about galaxies?'" (#1)

To help guide future development of tours, general visitors were asked to imagine what the MMT guide of the future might look like. Many visitor responses described it as an interactive, immersive experience. The tour would use advanced screen technologies (17 of 100 comments, or 17%) with glasses that could simulate a large screen and inherently, be hands-free: "It would be "a 3-D experience with glasses" (#64). It would be "smart," knowing where visitors are in the gallery and personalizing information based on location and for some, their interests and preferences (9 of 100 comments, or 9%). It would be interactive, just like exhibits in the gallery are interactive, and perhaps even allow visitors to ask it questions and receive answers (18 of 100 comments, or 18%). One child described a ride-like experience: it would be "a ride... the floating car was cool; something like that. Or a simulator or virtual reality goggles so you feel like you're really flying, say, or something" (#62). A couple of people mentioned having live interpreters to take them around on a person-based tour, emphasizing the fundamental value some visitors place on human interaction (7 of 100 comments, or 7%).

IV. DISCUSSION

Summary of Findings

In summary, much was learned from the web statistics, sales data, interviews, case studies, and follow-up interviews with visitors who used the Multimedia Tour and its online bookmarks and visitors who did not rent the Tour at all.

Visitors who rented the Tour were more likely to be male, have used audio tours before and had positive experiences, and be greater *Star Wars* fans interested in science and technology. These visitors liked the *Behind the Scenes* MMT content most and reported highest levels of learning surrounding that issue. Additionally, they enjoyed the fact that the Tour was nonlinear promoting a self-paced experience and allowing additional information to be accessed through the Tour's options. There were a small number of people who were discontented with the MMT, saying that it got in the way and was not different from the exhibit videos.

From the case studies, we see that the MMT promoted a largely auditory learning experience about *Behind the Scenes*; it often led to an independent learning experience with little interaction between visitors and very little use of interactives. Visitors thought that it ought to be easier to locate the stops. The traditional mode of making subtle tour stop signage did not work in an exhibition that had a non-linear path and many exhibits. Future implementations should also have more content that was significantly different from what the exhibits already offered, featured more *Behind the Scenes*, and personalized information presented.

In follow-up phone interviews, many MMT users reported that the Tour enriched their experience with additional information and a multisensory way to take in information. Their memories were skewed toward *Star Wars* content. At home, learning for general MMT and non-MMT visitors did not necessarily continue beyond the small percentage of MMT users who picked up bookmarks. These bookmarks often reinforced content learned in the exhibition, such as the development of the Darth Vader character and the science behind lightsabers. Many of the bookmark users we spoke with followed up with other links on the bookmark webpages as well. We can extrapolate that bookmark users were the most motivated and interested group of individuals who used the exhibition and that such information might appeal to this select group of individuals based on their higher levels of interest in *Star Wars* and science and technology.

Visitors who chose not to rent the MMT often felt it would get in the way of their exhibit experience with their group, would have decreased their independence and would have made their visit too expensive. In addition, many had not liked previous experiences with tours. According to visitors, such tours ought to be free, interactive, conducive to groups and hands-free. Years from now, it might offer more immersive experiences by using smaller technology, such as a pair of glasses to see large projections; it might also be "smart" in being aware of

users' location and personal interests. There was also a small group of respondents that says it would not ever use a tour, unless they were complete novices at the subject of the exhibition.

From the deaf focus groups, we found the ASL version of the MMT gave a sense of independence, but could have been designed to be more visual, needed targeted advertising, a keypad, and outlines of the stops.

All together, findings from the Museum of Science's Multimedia Tour raised several important messages and questions for the field to consider.

Message 1: The Tour Has Value in Enriching Visitor Experience and Providing Access to More Content

In context of the MMT's original goals the Tour succeeded on many levels in providing most visitors with the deeper level of information they were seeking through its interviews, bookmarks and links. In their follow-up interviews, some visitors recognized the value of hearing others' perspectives in broadening their own views and were able to make connections in the science behind the film:

> *I think the MMT was nice because it provided me with other people's opinions and ideas about what we were seeing. I feel if I just gone in and went in, I would have seen what I already knew - I would have picked up some stuff about science. behind exhibit but I wouldn't have understood place of that in the movies themselves but a lot of science exploration now is going back to the movies now. So I think a lot of the interviews on the Tour prompted a lot on that tour. (MMT user, #75)*

The handheld tour slowed visitors' experiences down and allowed them to consider exhibits that they normally would have stopped at for just a few seconds, especially if no video or extensive label copy was displayed. It furthermore provided a multisensory experience that visitors found compelling and enjoyable, especially when crowding was an issue and the exhibit videos were inaccessible. As many visitors expressed in the exit interviews as well, having the option to select more information and being able to decide what stop to do next made using the Tour a pleasant experience. For many Tour users, the guide was a self-sufficient experience in the gallery. Future blockbuster exhibitions the Museum of Science develops should certainly have some type of personalized tour; these types of tours should also be considered in some of the Museum's permanent galleries.

Message 2: ASL Tour is Important, but Creating One is Not as Straightforward as Originally Assumed

Overall, the handheld ASL Multimedia Tour is an honorable first step in including an important population. Similar to remedial evaluation findings (Tisdal, 2006), in which Tisdal followed one deaf visitor and his hearing wife throughout the gallery, visitors felt much more

comfortable and at ease having information in their own language. Many were very pleased that the ASL Multimedia Tour gave them access to information and they seemed to enjoy the content. It was a symbolic invitation into the Museum. More largely, however, the focus groups shed perspective on differences in the way deaf persons perceive and experience an exhibition as compared to hearing persons. Cultural differences among the deaf and hearing arose in definitions of timing, learning styles and preferences and norms for accessing information.

Cultural Difference 1: Timing

> *I think [it's important to] emphasize we live in an iPod culture. [We] continually get [a] stream of information. [But] remember, we [deaf people] live life in translation. It's a vague thing. (Mitt, 12/3/05).*

From the focus group, we gained an understanding of the fundamental difference in timing – of living life in translation. Everything – from hearing about events broadcast via email, text message or radios—takes greater time for deaf people to understsandto than hearing people, in part due to translator availability and in part due to the fundamental nature of their culture where information always comes delayed. In contrast to our society's rapid changes in technology—of podcasts and Blackberries–which are only accelerating the pace at which we receive and expect information, this cultural shifting is not consistent for deaf people.

To better grasp the "life in translation" timing concept, one focus group participant suggested handheld designers go around the entire exhibition watching the ASL tour to get a better sense of what the deaf person's experience is like. In doing so, one would soon realize that deaf users spend a considerable amount of time on the handheld for information – it was akin to a hearing person only having a scrolling text-only tour without any sound. In effect, if you look away, you miss information.

Cultural Difference 2: Differences in Learning Styles and Preferences

Because deaf individuals are also often considered dependent learners, they need a lot of structure in their learning (Lang, Stinson, Kavanaugh, Liu & Basile, 1999). Furthermore, they prefer seeing many visuals. As a field, we can move forward to a better understanding of these cultural differences and preferences in learning styles by playing upon deaf individuals' strong visual orientation. As emphasized during the focus groups, Multimedia Tours should have plenty of imagery. There should be more video clips of artifacts in motion or in creation phases interspersed among the Tour. Taking the suggestions one step farther, perhaps one could learn more information by selecting highlighted artifacts, similar to Woodruff, Aoki, Hurst, & Szymanski's (2001) suggestions. Drawing from the formal education literature, animation could be used to illustrate concepts that are being communicated by using movement. While Antenna Audio's Proctor (2005) wrote that ASL tours should not be a word for word direct translation, it should be argued that the statement be extended further so that content and features are not directly translated either. Truly different content needs to be

integrated into the descriptions of each stop accompanying the MMT, including a brief introductory description of the stop to help structure learning and provide visitors with the ability to choose whether or not they wish to watch the full segment.

Cultural Difference 3: Cultural Norms for the Deaf and the Hearing

Participants brought us into their culture, where they frequently use Sidekicks or cellular devices that have keyboards, not T9 keypad configurations. They also explained that they are so used to not having access to programs and events in their primary language, that without interpretation symbols on the Multimedia Tour signs and advertisements, participants will not be aware of services tailored to them.

In reflection, one of the original intentions of the institution was to provide a guide for deaf in their own language, leveraging the video capabilities of the handheld. In many ways, our original assumptions were that providing a tour would be better than not and that we could provide a straightforward translation of the hearing Multimedia Tour. However, through the focus groups, we have realized the naivety of our assumptions.

Furthermore, upon reexamining the original goals of the MMT, it becomes apparent that two of the goals contradict one another. One the one hand, we were trying to provide deaf users with access, but on the other hand, we were trying to provide a deeper level of knowledge. What's missing was an intermediary step – an introduction to the exhibition that provides basic information about it. By jumping right to the goal of providing nuanced, in-depth information –in the form of translation, we missed providing basic level information like what exhibit labels provide.

As technology continues to change and as it becomes easier to incorporate ASL into video-based technologies, museums and other cultural institutions should think about ways of providing deaf individuals access learning in their primary language. As many focus group participants said themselves, with such handhelds, the Museum itself could potentially be looking at another source of revenue – the deaf community would be more likely to feel welcome and visit the Museum of Science if handhelds were prevalent and well advertised. If museums, themselves, cannot acquire resources to do so, they should find ways to work in partnership with local deaf organizations or companies to ensure that deaf individuals have the opportunity to learn in their primary language at our cultural institutions through iPods or other handhelds. The deaf are an important audience we should and can reach much more easily through the advancement of technologies. Future projects using ASL should not only focus on the design of the handheld, but also the inclusion of more exhibitions (Friedman, 2000).

Message 3: Tour's Design Conflicted with Promotion of Interactivity

Despite visitors' general satisfaction and the successes of the MMT, some pedagogical challenges were encountered. A dominant philosophy of museums is that the visit is defined by experiencing it with the family and friends with when one visits (Hood, 1983; Dierking &

Falk, 2000; Borun, Dritsas, Johnson, Peter, Wagner, Fadigan *et. al*, 1998; Leinhardt & Knutson, 2004; Ash, 2003; Leinhardt, Crowly & Knutson, 2002). Whereas other literature (Woodruff, Szymanski, Aoki & Hurst, 2001) has captured the conversations that do take place in other museums' MMT users, in the *Star Wars* exhibition, the types of social interactions observed among visitor groups were few and weak. This might be because many conversations of non-MMT users were related to visitors' use of interactives and MMT visitors were observed not using many interactives. The lack of conversation may also be due to the tour's audio-heavy design, in which visitors were required to wear headphones; Woodruff *et al.* (2001) showed that having an open speaker promoted greater sharing and interaction among group members.

Furthermore, in science museums that are based in constructivism, it is hoped that visitors learn through experimentation. A fundamental part of the Museum and the exhibition's mission is to provide hands-on constructivist experiences in which visitors build their own meaning through experimentation. Unlike art museums, where understanding typically comes from interpretation of the piece's history and the artist's background, it is believed that anyone can access and create meaning in the science museum. Could visitors understand a scientific principle such as magnetism or how balance works by listening to 30 second clips and without trying it out? Collaboration and conversation are important aspects of their museum social experience.

It seems that one possible way to encourage interactivity is through featuring content on the MMT that provides support, further knowledge and instructions on the handhelds. While 4 of the 11 interactives were featured, arguably more interactives should have been featured. Moveover, the manner of interactives' interpretation could have been dramatically different. In this Tour's description of the *Robot Engineering Design Lab*, one of the exhibition's main interactives was presented in a more informational and ponderous manner rather than inquiry based:

> *In this activity area you can build a droid that moves by sensing its surroundings. What you'll be doing is like the professional roboticists who design, build and test robots to work around the home, operate in environments dangerous to humans, and even explore distant planets. In fact, sometime in the future, it may not be humans who discover the first verified alien life on another planet. Instead, that honor will probably go to a robot that we send to another world – to perhaps Mars or Jupiter's moon Europa – a robot built, programmed and watched by us on Earth millions of miles away (Bourne, 2005).*

The first three lines directly instructed listeners about the premise of the activity from a removed authoritative standpoint. Instead of saying "In this activity area you *can* build a robot," the narrator might say "Try this activity out! Here you are a robot scientist and your mission is to..." It might even prompt visitors to take the headphones off and explained that if visitors need additional help or had questions on how this technology worked, they can consult the MMT. These options could definitely be useful, especially since visitors had difficulties at certain stations. For artifact-based exhibits, interactivity could be built by polling and posing questions as part of the handheld's design to promote conversation.

Moving forward, the next generation of handhelds ought to be designed by constructivist-minded professionals with strong inquiry-based frameworks designed to work in a science museum. Content must be tested to see if it is engaging and reinforcing and encourages multimodal behaviors, like listening and speaking, looking and examining, question asking and engagement through trying out hands-on activities.

Message 4: There was Conflict between MMT Content and Meeting Educational Goals and Visitor Satisfaction

Tellis and Proctor's claim (2004) that the handheld's content is what matters most to visitors resounded with Museum MMT users. In their recommendations and their expressions of disappointment, MMT users reiterated that content on the handheld ought to be truly unique. People wanted fundamentally different foci and content. A review of certain stops by Research staff confirmed that content was surprisingly repetitive of the videos. While the exhibition development process generates a lot of information that is not used, this MMT proves that reusing the leftover video clips was not a compelling approach for visitors, especially when presented this information on a different device that implied information was going to be different.

From the perspective of museum educators, the content issue played out in terms of meeting educational goals. In essence, while some follow up interviewees reported learning about others' perspectives and the science and technology in the film, from the MMT, other visitors reported learning more about the movie's development and special effects – something the exhibit's Content Outline had claimed the exhibition was not about: "Most science centers build around motion picture themes have focused on the science, technology and art of making a film. This exhibit will focus on the future technologies depicted in the movies, the real science behind them, and the current research going on…" (Museum of Science, 2004). The exhibition's educational goals were:

- *To illustrate the nature of technology by engaging visitors in activities in which they use 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 future 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.*

However, it is unclear if visitors were learning as much about the science behind the technologies through the MMT. An example stop is the *Millenium Falcon*, with content that seems more fitting for an expo:

> *While growing up in Modesto, California, George Lucas rebuilt and raced cars. In the Star Wars movies, Lucas' love of tinkering with automobiles is most recognizable in Han Solo and Chewbacca's endless efforts to keep the Millennium Falcon flying. The Falcon is a perfect example of what George calls his "used universe." Instead of looking new and shiny, this spaceship is scratched, dented, and in need of a good bath. The Falcon, like its owner, has experienced an active life. Like George Lucas and his racecars in Modesto, Han tinkers with his beloved ship so much that we understand why Lando Calrissian calls the Falcon "the fastest hunk of junk in the galaxy." With the release of the original Star Wars movie in 1977, this was a startling way of showing a futuristic, but realistically lived-in, universe. To hear more, select the "Behind the Scenes" option for a video interview with Alex Jaeger, of the Star Wars art department.*

Arguably a more direct connection to science and technology could have been established than a discussion of a model's history. In total, thirteen of the 38 audio and video segments spoke of developments in research and technology where artifacts were being interpreted. General non-MMT visitors' reports on learning from the exhibition tended to involve developments in research; visitors' reported learning from the MMT facts there were basketball players inside the Wookiee costumes or how the landspeeder was made to appear flying.

The disparity between educational goals of the exhibition and the MMT suggest the need for stronger and more direct oversight of MMT content development. A question this raises and which the evaluation cannot answer is whether the *Star Wars* fan audience who rented such a Tour would be interested in content that was less about special effects and more about parallels between the film's and current technologies – or if they would simply bypass this real world related content.

Message 5: Value and Content of Bookmarking Needs to be Reexamined

Compared to the Tate Modern's Multimedia Tour runs where 40 to 60% provided their email address to docents for information to be sent home (Proctor & Tellis, 2004), only 10% of Museum of Science visitors decided to bookmark information. With only 10% of exhibition visitors renting the Tour, 10% of that group bookmarking, and 37% of visitors who bookmarked picking up their link, a dismal 0.02% of exhibition visitors made use of the bookmarks. It is possible that the word "bookmarking" was ambiguous to the Museum of Science visitors so that they did not know what to make of it. Visitors did not seem to know why they would want such information; many MMT visitors conceptualized their time learning would occur only within

museum walls. Even when we distributed paper copies of bookmarks as part of an experiment, there was a very low take-up rate given the masses of visitors who passed through the exhibition. Besides the bookmark survey respondents, the general non-MMT and MMT visitors reported that they are not used to frequenting the MOS website. They need to be compelled to go to the website; getting "more information" about the exhibits was not exciting enough. Furthermore, the online bookmark survey respondents ranked their enjoyment and learning from the bookmarks lower than the MMT or the exhibition. Follow-up interviews found that this may be because the information was too similar.

In rethinking the bookmarking, content must be significantly different and distinct from exhibition or MMT content, such as being able to take photographs at the exhibit of artifacts or interactives, like the Exploratorium did, or of the visitors themselves, like Disney's Innoventions' IBM "Thinking of you" postcard kiosk. Since bookmark users' would be able to sit and presumably use content for longer periods of time online than in the exhibition, the website might have games, polls, bulletin boards, more film clips and different *Behind the Scenes* information that took reinforcing content one step beyond and provided novel content. With visitors expressing enjoyment in seeing other visitors' inputs (Boehner, Sengers, Medynskiy & Gay, 2004), the MMT might be a way to find out about other visitors' experiences and thoughts. The bookmarks should definitely allow visitors the option to access bookmarks they did not select if they want to explore even more content they hadn't thought of at the time. Like the handheld, the bookmarks should provide even more opportunities to pursue deeper levels of information with more external URL links and other options.

V. CONCLUSION

Fundamentally, we return to the question of what mission and what values the Museum places on social group interaction and use of interactives when using the MMT. Does a MMT come with its own set of expectations of learning and visitor behaviors that differ from an exhibition's goals? Alternatively, do visitors always need to be engaging with interactives in science museums to fully understand exhibition messages? Ideally, there would be some type of balance in the design of a MMT where the decision would not be an either/or choice.

It should be noted that while the handheld ASL Multimedia Tour was highly valued in many regards, having a Tour with or without ASL capabilities was not absolutely necessary in a rich, hands-on, heavily multimedia-based exhibition. It was a high cost and low impact project without which, realistically speaking, deaf visitors still could have navigated throughout the universally designed exhibition. Still, tours must be undertaken on an experimental basis in science museums. As a survey found, revenue is viewed as one of the least advantageous outcomes of using "digital technology to enhance the visitor experience" (Schwarzer, 2001 as cited in Samis & Pau, 2006)

Yet this technology is promising and much can be learned from effectively designed guides. Non-MMT users had many zany ideas of how to design MMT of the future. Technology is ever advancing and it is difficult to keep up with; much has been learned since the production of this Tour from other museums' experiences. As evidenced by the breakdown of the bookmarking system, during which hundreds of bookmarks were backlogged and not emailed to visitors over the course of a few months, as an industry, the technology has not yet been perfected.

Tours currently being developed emphasize the visitor focus on looking at the artifacts and recognize the power of the first person story (Gordy, Proctor, Portway, Sayre, Dowden, Topp et al., 2006). The next direction science museum tours need to take are encouraging greater participation in the museum's hands-on activities and in having conversation with other group members.

Unlike much of the research and applications of handheld tours in art settings, science museums are in a unique position as constructivist learning environments and handheld developers might need to work with a different set of guiding frameworks when developing their content for science museums. In science museums, the handheld Multimedia Tour should be designed not as something one can become dependent on to receive information and experience the museum, but as a way to make the experience more empowering, accessible, fun and intellectually stimulating. It should be a resource such that someone "doesn't get" the content, that it would provide scaffolding so that understanding is achieved. Ultimately, prototyping could alleviate problems if handhelds are designed to accompany permanent exhibitions with many artifacts like *Natural Mysteries* and have significantly different content and a unique feel from the exhibit.

Future iterations of such handheld content might have:

- Synching and ability for a group to do tour together
- The ability to skip through whole clip
- Different developed content for an ASL Tour that is highly visual, includes basic exhibit labels and outlined pamphlets of information
- *Behind the Scenes* information that is aligned with exhibition messages and educational goals
- Factoids
- Question posing that leads toward group conversation
- Prompts to try the interactive
- Polling sections
- A digital character to serve as a tour guide
- Ability to select stops based on a visual representation of the gallery (i.e., from a map)

Bookmarking content might have:

- Collection of additional artifacts not in the exhibit and facts about them
- Games
- Polling sections and message boards, including responses from LucasFilm staff
- The ability to see all bookmarks
- Additional *Behind the Scenes* information
- More weblinks

The selection of features would of course take into heavy consideration the exhibition's educational goals.

It may very well be that PDAs will become obsolete or less popular with the continuing surge of technology like cellular phone and iPod tours (e.g., Liberty Science Center, Museum of Modern Art). While the device might change, what won't change are blockbuster exhibitions which have

crowding issues and visitors who have particularly high interest levels in the subject matter. For these reasons, multimedia handheld tours will remain great ideas. Continuing to explore the promises of this technology could lead to a deeper, more educational and social experience for visitors; however, we need to take these lessons in hand and continue to seek the best design for our visitors.

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APPENDIX A Star Wars Exhibits, PDA and Bookmarking by Content and Medium

		EXHIBIT					MULTIMEDIA TOUR					BOOKMARKING			
		Content	Artifact	Interactive	EDL	Video	PDA stop?	Content	Audio	Video	Photo	Book-mark?	Content	Video	Links
.01X	*X-wing starfighter*	SW	X			X	N								
1.01	*Luke Skywalker's Landspeeder*	SW	X			X	#1	SW	X	X	X	Y	SW		X
1.02	*Ride on a magnetic field*	RW				X	N								
1.02B	*Real world speeders*	RW	X			X	#7	RW	X			Y	RW		X
1.02C	*Electrostatic lifter*	RW		X			N								
1.03	*Make the jump to lightspeed*	SW	X			X	N								
1.04	*Star Wars space ships*	SW	X			X	#19	SW	X			Y	SW		X
1.05A	*Living on Tatooine*	SW-RW	X			X	#3	SW-RW	X		X	Y	RW		X
							#4	SW-RW	X			Y	RW		X
1.05B	*Building communities*	RW-SW		X			#5	RW	X			Y	RW		X
1.06	*Today's spacecraft*	RW	X				#21	RW	X			Y	RW		X
							#22	RW	X			Y	RW		X
1.07A	*Living on Coruscant*	SW	X			X	#2	SW	X		X	Y	RW		X
1.07B	*Moving Down the Skyway*	RW-SW		X			N								
1.08	*Ride on a cushion of air*	RW		X		X	N								
1.09	*Maglev EDL*	RW		X	X		#6	RW	X		X	Y	SW		X
2	*Robots & people*	RW-SW	X				#18	SW	X			Y	SW-RW	X	X
2.01A	*Star Wars robots*	SW	X			X	#7	RW	X			Y	RW	X	X
2.01B	*Robotics today*	RW	X			X	#16	SW	X			Y	RW	X	X
2.02	*Robot object theater*	RW-SW				X	N								
2.03	*Living on Kashyyyk*	RW-SW	X				#10	RW	X			Y	RW		X
2.05	*Static/Dynamic stabilization*	RW		X			N								

2.06	*Living on Hoth*	SW	X				N								
2.07	*Walking is Not Easy*	RW	X	X			N								
2.08	*Robot vision*	RW		X			#11	RW	X			Y	RW		X
		EXHIBIT					**MULTIMEDIA TOUR**					**BOOKMARKING**			
		Content	**Artifact**	**Interactive**	**EDL**	**Video**	**PDA stop?**	**Content**	**Audio**	**Video**	**Photo**	**Book-mark?**	**Content**	**Video**	**Links**
2.09	*Expressive robot*	RW		X comp			N							interactive	
2.1	*Star Wars weapons*	SW	X				#9	SW-RW	X		X	Y	RW		N
2.11	*Darth Vader*	SW	X				#12	SW-RW				Y	RW-SW		X
2.11A	*Prosthetics and implants*	RW-SW	X				#13	RW	X			Y	RW	Text interview	
							#14	RW				Y	RW		X
2.11B	*Human or machine?*	RW		X comp			N								
2.12	*Robot EDL*	RW		X		X	#15	SW				Y	RW		X

APPENDIX B MMT User Interview Response Categories

MMTQ1. What made you decide to rent the MMT?

Codes	N	%	Example comment
Features would add to experience	51	42%	
• Added Information	25	21%	"I thought it would be more information that wasn't in the exhibit" (#26)
• Enhance overall experience	12	10%	"I thought it would help us get more about the exhibit..." (#28)
• Multimodal features	9	7%	"[They] had them [in] other places and [I] find [it] smoother going; speed[s] it up. I am a slow reader." (#59)
• *Behind the Scenes* perspective	4	3%	"I wanted the inside info. . . Didn't want to wait to have to push a button [on an exhibit component]; wanted behind-the-scenes. I saw it on the web site." (#15)
• Bookmarking feature	1	1%	"[I was] most interested in [the] ability to e-mail bookmarks." (#60)
Because of other people	34	28%	
• Recommended to me by a friend, MoS or Antenna staff	17	15%	"[It] was recommended by someone who had already seen the exhibit." (#7)
• People in my group got it	17	15%	"My husband -- I told him I'd do whatever he wants today; it's his day." (#4)
One's background	21	17%	
• Used it in other museums before	16	13%	"[I] get them at museums. [They are] really helpful [at the] MFA." (#58)
• Identify personally with film / SW fan	5	4%	"I like *Star Wars*." (#42)
Interest in concept	8	7%	
• Technology caught my eye	4	3%	"[It] looked neat. New technology. [?] more information." (#74)
• Curious of what it'd be like	4	3%	"I thought we should try it out." (#64)
Other Reasons	7	6%	
• Responded with complaint or limitation of MMT	4	3%	"I was expecting more content. [I thought] I wouldn't learn as much without it. But if I got that [the same content] from the exhibit, why get the PDA?" (#36)
• No response	3	2%	
Total comments	121	100%	

MMTQ3. What aspect of the MMTG did you find most compelling?

Codes	N	%	Example comment
Content/Information/Features	**81**	**73%**	
• Added information overall	24	21%	"I guess just the additional background [that is] not evident in [a] few sentences at each station." (#77)
• *Behind the Scenes* clips	23	20%	"[It was] interesting to find out how they used technology to give [the] illusion of a speeding land cruiser -- [and the technology could be] basic or complex." (#39)
• Multimodal features	16	14%	"video; something above and beyond [just] audio" (#37)
• Options for more content	10	9%	"its options. It didn't ramble on too long so you could choose to go on [yourself]." (#35)
• Specific content on the MMT	7	6%	"actual spaceship (speeder)… how they built them…about the trick photography" (#17)
• Bookmarks to be sent home	2	2%	"The fact that you can get more information sent to [your] e-mail address." (#76)
Use in the Gallery / Exhibit Experience	**20**	**18%**	
• Exhibit experience more convenient	12	11%	"I enjoyed [it]; easy to use and clear, understandable. [I'm] not a total technocrat." (#69)
• Ability to self-pace exhibit experience	8	7%	"fact that you could choose the order…you could wander, go back, repeat, skip or stop…very versatile" (#22)
Nothing was compelling	10	9%	Didn't add as much because the exhibit is already so multi-media intensive (#25)
No response	1	1%	
Total	113	100%	

MMTQ9. What did you learn from the MMTG that you didn't know before?

Codes	N	%	Example comment
Content knowledge	64	73%	
• How the films were made	40	45%	"Just -- probably some of the places that they shot the scenes; sounds, or vehicles -- just interesting. George Lucas' thought process." (#31)
• Real world connection to *Star Wars*	11	13%	"I learned about a lot of the advancements in movie-making that are applying to everyday life." (#28)

• *Star Wars* information	7	8%	"Detailed information on [the] background of [the] *Star Wars* props..." (#66)
• Real World science knowledge	6	7%	"[I] liked [the] exhibits on Real World technology, prosthetics and cochlear ear, showing how they can take that back -- use those ideas -- very educational." (#63)
Learned Nothing or Very Little	14	16%	"I don't know much about *Star Wars* [but I learned more from] the exhibit than the tour guide." (#57)
Learned a Lot	7	8%	"All of it was new and interesting" (#13)
Other	3	3%	"learned about…got ideas for how to develop a guide like this" (#14)
• Responded with complaint or limitation of MMT	2	2%	"[I] would not use it again." (#45)
Total	88	100%	

MMTQ4. Why did you like (SW film clips/*Behind the Scenes*/Descriptions of RW objects/ Photos of RW objects) content the most?

Codes	N	%	Example comment
Content on the MMT	**54**	55%	
• *Behind the Scenes* perspective	19	19%	"I liked hearing[?] about why they used the things that they used, what kinds of sounds, behind-the-scenes, thought process." (#31)
• Added information or value	12	12%	"Seemed to add more interest and information." (#40)
• Multimodal (video, audio) features	8	8%	"I liked when they combined the explanations with video clips and real life pictures. [It] added a lot to have both there. [I] never experienced that before on a tour guide." (#12)
• Specific content	8	8%	Things about plasma and real light sabers. (#34)
• Real World connection to *Star Wars*	7	7%	"Association between real world and how the movie was used…The maglev train, and how… to hover. [Applying] to our life today." (#29)
Appealed to My Needs, Interests & Knowledge	33	34%	
• Identified personally with that content	19	19%	"Because I am fascinated with film and concepts on the production of film: design, technology, ambitions of special effects and sound production." (#8)
• Didn't do or know of other content on MMT	7	7%	"[I] didn't do Real World stuff. [--> So of the *Star Wars* stuff, why did you prefer the interviews to the film clips?] [I had] seen the clips before." (#41)
• Provided a stronger connection to the exhibit	7	7%	"because it tied-in better with the exhibit" (#25)

Other	9	9%	"[It's] all integrated; hard to say. [The] interviews with people were fun." (#44)
• Voiced Unhappiness with MMT	5	5%	"Mediocre… Narration of objects. [It] should have an option for more detailed description." (#45)
No responses	2	2%	
Total	98	99%	

MMTQ5. In what ways was the TG most helpful with the (SW, RW or hands-on) exhibits?

Codes	N	%	Example comment
Content Information	**45**	48%	
• Additional Information or value	17	18%	"[They] seemed to be less self-explanatory; required more privileged information than [that provided by] text at the display itself." (#8)
• *Behind the Scenes* perspective	16	17%	"The content about how [they] made the movie and what people were thinking about." (#5)
• Real World connection to *Star Wars*	3	3%	"Because it showed the relationship between *Star Wars* & real world like the car and speeder" (#2)
• Multimodal (video, audio)	4	4%	"visual learning…other stuff was static…film clips tied [things] together nicely" (#24)
• Specific content information	5	5%	"Things about plasma and real light sabers." (#47)
Appealed to my Needs & Interests	26	28%	
• Identify personally with the content	7	7%	"because I was more interested in real world [content]" (#33)
• Prefer by default – didn't do other types of exhibits	19	20%	"[I] didn't do Real World stuff." (#41)
Helped me in the Gallery	8	9%	
• Exhibit connection	7	7%	"seeing what I was looking at, but in context [of the film]" (#15)
• Alleviated Crowding	1	1%	"I wanted additional information on them and couldn't read [the] cards [because I was too] far back in." (#73)
Wasn't helpful – voiced dissatisfaction	6	6%	"didn't like any of it" (#6)
Other	10	11%	"[I] didn't see them all." (#57)
• No response	9	10%	
Total	94	98%	

MMTQ8NB. What made you decide not to bookmark?

Codes	N	%	Example comment
• Didn't understand what it was	14	24%	"What does that [bookmarking] mean? [interviewer briefly explained what bookmarking is] Oh. If that had been explained I would have done it." (#17)
• Not interested	11	17%	"not interested; just wanted to hear it" (#26)
• In general, just didn't	10	19%	"Forgot about it. Didn't think it was more info., but would be a neat thing to do, not because I wanted more info., [but because it would be neat] to be able to e-mail myself while standing there [in front of exhibit" (#25)
• Had enough information	5	9%	"I really don't need the information." (#28)
• Wasn't conducive to my social group	5	9%	"If I didn't have two teenage kids [with me,] I would have." (#66)
• Won't ever read the bookmarks	4	7%	"[I'm] busy, [and there's] no time to read later" (#22)
• Don't want more emails	4	7%	"The last thing I want is someone sending me more e-mail. If I give you my e-mail, I don't know what is going to be done with it." (#29)
• Can do myself	2	3%	"I have a computer at home, so I can just go how and search for it myself [I.e. the info" (#16)
• Not a computer user	2	3%	"[I] never like to [do] anything like that on my computer. [I'm] overcautious." (#51)
• Time inside exhibit was limited	1	2%	"Time" (#30)
Total	58	100%	

MMTQ6. What did you find difficult or problematic in using the MMT?

Codes	N	%	Example comment
Interface and Technical Aspects			
• High touch sensitivity	10	12%	"[The] touch screen; [it] hangs around [your] neck, bounces off a button [and it goes off prematurely]. Nice if [it could] pick up a radio signal [from the exhibit case]." (#41)
• Interface confusing	9	11%	"[I] didn't know how to get back to [the] regular keypad until [I] found [the] Back [button]." (#42)
• Technical issues arose	6	7%	"It glitched on me. Error screen popped up. I had to go to the front to get it fixed." (#25)
• Headphones got in the way	4	5%	"[My] three kids using them had trouble adjusting them to [their] size." (#46)
• Adjusting volume difficult	3	4%	"Oh, one little problem: figuring out where the volume was." (#12)

• Process of entering email	2	2%	"Putting in my e-mail address." (#48)
Difficulties In the Gallery	19	23%	
• Finding stops	18	22%	"[It] was difficult to know what to listen to, what the exhibit was talking to you about or the audiorecording… What was being presented at the exhibit -- [if it] had audio and video." (#58)
• Crowding	1	1%	"Using [the] tour guide [was] not difficult at all. [The] most difficult -- so many people involved; [the] number of individuals in the room per cubic footage" (#50)
Content Didn't Match Up to Expectations	2	2%	"Well some of things [I] like wanted to know [weren't there] like General Grievus." (#2)
Nothing was Difficult	26	32%	"No problems…and I'm not the most technical person!" (#17)
Total	81	98%	

MMTQ10. What ideas or suggestions do you have for Improvement?

Codes	N	%	Example comment
Content/Information	29	35%	
• More, different content	13	16%	"More interviews from the actors, [?], maybe George Lucas himself, also." (#72)
• Multimodal (video, audio) features	7	8%	"[It's a] great tool, to maximize its use. [There are] three [elements:] sound, visual, [and] moving visual. [Use] sound where [there is] something else to look at." (#69)
• More information and options	3	4%	"I loved choosing how in-depth to go. [Have] more options, more on [the] PDA about different exhibits." (#45)
• More stops	3	4%	"[It] would be wonderful to have one at every station. Different stations within the exhibit." (#77)
• Change stop length	3	4%	"more #s/stops, but less length in each" (#23)
Logistics	30	36%	
• More obvious stop markers	10	12%	"[It] wasn't obvious what [the] numbers were on the exhibits. [There was] no geographic correlation. Like an art museum…" (#44)
• Better instructions	6	7%	"Sometimes I had to fiddle with it to get back to the keyboard {It would be good] if there were a little more info on how to use it [I.e. the PDA tour]. Needs a simple button push for pause [and] to go back to "home"." (#15)
• Less cumbersome with the headphones	5	6%	"[It] is potentially very good, [but] not a good delivery. [There is no] break-away [in case it gets] tangled. [I suggest a] belt clip, [and/or a]

			Blue Tooth [that] tucks [into your] ear." (#45)
• Improve interface	5	6%	"Don't have to physically put in [the numbers]." (#41)
• Eliminate technical issues	4	5%	"No button on the side." (#52)
No suggestions	19	23%	"I can't say I have any suggestions." (#8)
Other	5	6%	
• Museum-wide applications	2	2%	"Other than making it museum-wide, I don't have [any]. At the MFA, you can use it at the special exhibits as well as the entire museum." (#12)
• Less touch sensitive	1	1%	"If it faced your body, it would beep [because] the touch screen was sensitive. It was an appropriate size…not too small." (#33)
• Design for social groups to use	1	1%	"[I'd] highly recommend [it] to people coming alone. Make [exp?] better if you have the time to use it, but if you are in a group that wants to stay together -- it's OK for a group that spreads out, but for one that wants to stay together, it's tougher to use." (#30)
• Lower price	1	1%	None. Maybe lower price." (#30)
Total	83	100%	

APPENDIX C Non-MMT User Interview Response Categories

NMMTQ2. As you were going through the exhibit, what questions did you have about anything you saw or learned?

Codes	N	%	Example comment
STAR WARS	**13**	17%	
• Costumes and artifacts content and authenticity	10	13%	"My #1 one was, were the costumes and figures from actual movies?" (Adult male, #11) "How come there wasn't Yoda stuff?" (Adult male, #19)
• How movies were made	3	4%	"I was trying to place things -- the movies. Like the more detailed things; what scenes" (Female adult, #23) "I would have liked to see explanations of [the] special effects." (Female adult, #7)
REAL WORLD	**9**	12%	"When we could expect to see these advances in technology." #8
• Robots	5	7%	"It made me think about what it would really -- how someone would really get a robot to work like a human being -- [the] technology [?] toward that." (Male adult, #43)
• Transplants	2	3%	"Yeah, the one that we did about tech implants in humans." (Female adult, #16)
• Space	1	1%	"More details of current spacecraft. [The] Ramjet." (#54)
• How much technology has changed or will change	**1**	1%	"It was cool [how it pointed out] the potential for robots in the future" (#2)
EXHIIBT INTERACTIVES	**6**	8%	"The part where there was a screen and you had to move cards around was confusing" (-female child, #31) "sometimes working on the lab areas, it would have been nice to have a person to explain it/ask questions to" (adult male, #75)
NO QUESTIONS	**45**	61%	"Not really. [It was] very self-explanatory" (male child, #17)
TOTAL	**73**	98%	

*Percentages do not always add up exactly to 100%

NMMTQ3. In what topics did the exhibit spark your interest?

Codes	N	%	Example comment
REAL WORLD	**41**	41%	
• Robots	22	22%	"the current-day robots, the Rhomba[?] and the PSA. [That was the] best thing." (#15)
• Transplants	7	7%	"bionic human parts" (#35)
• Real World relationship to *Star Wars*	6	6%	"Robots, and where we are in relation to the movies… and how close we are to the *Star Wars* capabilities" (#12)
• How much technology has changed	4	4%	"advances in technology since I was these kids' age" (#74)

• Space	2	2%	"The concept behind the different imaginary planets." (#7)
INTERACTIVES	**29**	29%	"All the hands-on stuff." (#22)
• Maglev	9	9%	"Maglev makes you think about how you could apply that; it wasn't clear how far we were from achieving our goal in that area" (#28)
• Robot Theater	5	5%	Much more about robots, after seeing that presentation [the Robot Theatre]. [I] didn't realize the depth of configuration of a robot.
• Hovercraft	3	3%	"hovercraft" (#71)
• Robot EDLs and walking	3	3%	"The -- I liked the thing with the robot -- shows you how it has balance -- how they're trying to get robots to simulate human walking."
• Interpretation	3	3%	"hair-dryer with the ball" (#65)
STAR WARS	**26**	26%	
• Costumes and artifacts	10	10%	"I like how they have a bunch of props and costumes." (#17)
• How movies were made	10	10%	"The difference way that they did [made] things, like how C 3PO was made; it showed you how they did it." (#21)
• Robots from films	3	3%	"Droids" (#73)
NOTHING	2	2%	"None" (#64)
EVERYTHING	1	1%	"All interesting"
OTHER	2	2%	"I've been living with this for year [-->how do you mean?] I'm a big fan and I'm involved myself in creative activity [music]. I like the way that *Star Wars* speaks through metaphors. I'm a big fan" (#32)
TOTAL	101	99%	

NMMTQ5Y. You were aware there was a MMT Guide. What made you decide not to get it?

Codes	N	%	Example comment
EXHIBIT EXPERIENCE PREFERENCES	**46**	57%	
• Not conducive to my social group	18	22%	"Plus, with two small kids, that would be too hard to try to keep their interest [in the MMT]" (#71) "If I'd been alone I might have, but I was with a group" (#28)
• Like being independent, unrestricted by Tour	14	17%	"I don't like anything that controls my processing, of [my] taking in information. I'm one of those people who revisits just to look at one or two things." (#32)
• Unnecessary to exhibit experience	8	10%	"we've watched all the movies lots of times; didn't think we really needed it [the MMT]; plus, it was $57 dollars already [I.e. for their family to come]" (#68)
• Dislike tour guides	6	9%	"Pain in the neck. [--> What do you mean?] You have to hold it, put it on; another thing to carry." (#47)
LOGISTICS	**30**	37%	

• Too expensive	17	21%	"I just didn't want to spend the extra money." (#59)
• Unfamiliar with MMT	7	9%	"I didn't know what it was" (#31)
• Limited time in exhibit	5	5%	"I guess we were somewhat short on time" (#54)
• Not a *Star Wars* Fan	1	1%	"[I'm] not a [*Star Wars*] freak… I have friends who are really into it." (#27)
OTHER	**5**	6%	"I don't know [why]. I didn't want to." (#74) "A friend [had visited the exhibit and} said [it was] not worth [the] extra money" (#8)
TOTAL	**81**	99%	

NMMTQ6. What types of things would you guess that the MMTG has on it?

Codes	N	%	Example comment
CONTENT	**77**	**69%**	
• Interpretation: explanation	25	22%	"A tool to take you through briefly and explain each object" (#32)
• Additional information	24	21%	"obviously, more specific information" (#72)
• Multimodal features (video, audio)	19	17%	"I'd assume audio only and even if it had a screen, I didn't need that because the exhibit already has multi-media in it…I didn't need the little bug in my ear" (#37)
• Interviews	4	4%	"interviews" (#8)
• Audio only	3	3%	"I don't know. I found most of those things are just audio clips. [I] didn't realize [these were?] hand-held palm things with multi-media clips." (#51)
• About the film: facts, trivia, clips, how it was made	2	2%	"[I would] hope more details about special effects." (#10)
NOTHING NEW	**7**	**6%**	"I really don't know." (#45)
• Not necessary for the exhibit	5	5%	"At every exhibit there is a film, and I don't mind reading. [A MMTG is] too oppressive for me." (#41)
• Same content as the exhibit	1	1%	"A lot of the same things [that were] written down." (#8)
EXPERIENCE INSIDE GALLERY	**15**	**14%**	
• Tour through the gallery	12	10%	"Step-by-step through the exhibits." (#47)
• Interactive qualities	3	3%	"I'm sure there was discussion -- I saw people standing for different periods of time. [Respondent volunteered the following:] I happened to take -- [I] saw a few fun games where they develop a passport -- get it stamped. So there is a reward. [It] needs to spark their knowledge base. Did that at [an] Indian museum." (#6)

• Web-based	3	3%	"Different exhibits all around the museum; if tehre was a thing that showed the costs and times so you could walk around and still know when the shows are." (#76)
OTHER	**11**	**10%**	
• No idea what it'd have	7	6%	"not really sure" (#38)
• Other	4	4%	"It would be cool to have one that's different for adults [versus] children; it would be neat to talk differently to adults" (#75)
Total	112	99%	

NMMTQ7. If you had rented the MMTG, what do you think you would have gotten from it?

Codes	N	%	Example comment
CONTENT	**55**	**64%**	
• Additional information	32	38%	"More information. Interesting little facts." (#17)
• Greater understanding of the exhibit	20	23%	"I'd probably be able to expalin a couple of things I came up short on with the kids." (#58)
• Interviews with people *Behind the Scenes*	2	2%	"interviews" (#12)
• Movie: How it was made	1	1%	"[I would] probably expect special effects stuff." (#10)
EXPERIENCE INSIDE GALLERY	**12**	14%	
• Would be a totally different experience	12	14%	"somehow makes you feel part of the exhibit/theme; would draw you in" (#29) "maybe more fulfilling experience" (#19)
NOTHING / DON'T KNOW	9	10%	"you wouldn't miss anything" (#21)
OTHER	**10**	**12%**	
• Other	8	10%	"What the exhibit [is] for: the advance of technology." (#55)
• No response	2	2%	
Total	86	100%	

NMMTQ8. For you to decide to use a MMT, what would it need to be like?

Codes	N	%	Example comment
CONTENT	**30**	32%	
• Information additional to the exhibit	10	11%	"I just want to learn more details about what I'm looking at -- what it does and how it works" (#75)

• Interactive	8	8%	"needs to have a map and be easy-to-follow; [have] an order/system, not just be a lecture…interactive. Maybe interviews and games" (#19)
• Multimodal	5	5%	"Maybe footage of examples of what it's displaying corresponding to what you're in front of: (#35)
• Have a preliminary understanding of MMT's content	7	7%	"Give me a list of what it will tell me about [in other words, tell me what I'm going to learn about up-front; promote what the content is up-front. For example, ask "Do you want to learn about levitation? Then rent this tour. Or want to learn about galaxies? " (#1)
USING THE HANDHELD	**27**	**28%**	
• Easy to use	10	11%	"easy to navigate, so you're not spending all your time fighting with the thing; easy to understand; easy to manipulate for everybody b/c not everyone is techno savvy; each topic doesn't take up a tremendous amount" (#72)
• Hands-free and easy to carry	8	8%	"Something small. Have a carry bag to put around your neck, not have to hold it, or clip [it] from [a] belt." (#48)
• Control functions	6	6%	"…obviously… reverse, fast forward, louder, softer" (#26)
• Personalize to my interests	3	3%	"If you were able to sort of customize it based on some preferences [of yours] geared toward your preferences" (#67)
IN THE EXHIBIT	**16**	**17%**	
• Conducive to my social group	8	8%	"I'd use one without kids. I love them. That's where they are losing people." (#24)
• Self-paced experience	5	5%	"Not too regimented -- [so you] wouldn't have to follow a path. Too linear. [I] want to go to [the] least crowded [area]. Non-linear." (#14)
• Tour	3	3%	"show times; a guided tour -- present you with a specific pathway [to take] or give you the choice so you could choose a pathway, like the 'costume path' or the 'robot path'" (#76)
OTHER	22	23%	
• No response	6	6%	
• Other	7	7%	"We've rented them in the past -- My family [is more] willing to rent if [the] topic is one where we don't know anything about [it]." (#42)
• Depends	3	3%	In some ways it just depends on how much the exhibit itself is providing. This one provided a lot, but in an art museum for example, the exhibit doesn't give you that much and some people don't like to read
• Still won't use it	2	2%	"If the exhibit is well-done, you don't need it."(#21)
• Novice to subject	2	2%	"If I were a total newbie to the subject then, yes" (##36)
• Richer context	2	2%	"Live characters. Someone in the costume of the character." (#6)
Total	95		

9. Describe to me what MMT in museums of the future might be like.

Codes	N	%	Example comment
SYSTEM	**36**	36%	
• Advanced visuals	17	17%	"I have no idea. Maybe virtual…Holographic." (#26)
• Web-based, "smart" system	9	9%	"A piece in your ear and a sensor that tells you where you are going. [Like a] mini global positioning [system]." (#27)
• Small size	6	6%	"Might be like smaller, maybe" (#17)
• Hands-free, not cumbersome	4	4%	"In the future, [they will] look like glasses. You will wear them. Hear it off of the arm of your glasses." (#14)
FEATURES, CONTENT	26	**26%**	
• Live person interpreting	7	7%	"a little group at the beginning of the whole museum to help you decide where to go" (#30) "Rent-a-nerd… You'd get a nerd to go around with them and explain all the details [of the exhibit]; someone to argue with and interact with; a live person." (#36)
• More information provided	5	5%	"It could give you additional information on topics that interest you and where to go to get more information [once you've left the museum] on those topics" (#70)
• More context to the exhibit	5	5%	"maybe could be 'in character' related to exhibit" (#29)
• Options	3	3%	"In [the] future, [you] can activate information at each exhibit. You can decide, do I understand or get another level of information" (#42)
• Multimodal	2	2%	"Audio, video, selective, point-and-click with a mouse, stop and start." (#57)
• How *Star Wars* film was made	2	2%	"maybe parts of the movie [in it]" (#31)
• Science demonstrations	2	2%	"More demonstrations in applying the science… I'd say, as we get more technologically enhanced, [the] exhibits [should?] get technologically enhanced." (#12)
EXPERIENCE IN GALLERY	25	25%	
• Interactive	18	18%	"It would be cool to have some sort of vehicle you're in. The vehicle tells you what you're looking at. Maybe you stop and interact and learn and then you get back in." (#75)
• Free	5	5%	"[It would be cool if the museum had tour guides that were] free" (#41)
• Own pace	2	2%	"To be able to go through and not rely on a tour guide" (#74)
OTHER RESPONSES	13	13%	
• Other	5	5%	"specificity [I.e. facts] takes away from the abstraction [concepts/themes]; let people in on the abstraction" (#32)
• Unnecessary to exhibit experience	5	5%	"If I go to museums, I want to see what the museum has to offer [I.e. the objects]. They [MMT] can be distracting, too much information; you lose track of what's in front of you. I can watch videos at

			home/listen to someone in my car." (#69)
• No idea	2	2%	"Boy, I have no idea." (#56)
• No response	1	1%	
Total	100	100%	

APPENDIX D MMT EXIT INTERVIEW QUESTIONNAIRE

This Is the 1st time the MoS is using a MMT Guide and we're trying to get feedback. Could I ask you a few questions?
1. On a scale from 1 to 10, where 1 is not at all satisfied & 10 is very satisfied, how satisfied were you with the MMT Guide? ____
(Probe: Knowing what you know now, would you get the Tour Guide again? Y N)

2. *Now I'd like you to take me through your experience, starting from the beginning.* What made you decide to rent the TG? (*Probe: What types of things did you expect it would have?)*

3. What aspect of the TG did you find most compelling? (*Probe: What value did it add to your experience?)*

4. The TG had: What content did you like the most? Why?
- SW film clips
- Behind the scenes interviews w/ *Star Wars* producers
- Descriptions of Real World objects/phenomena
- Photos of Real World objects

5. Now inside the gallery, there were many exhibits: What kinds of exhibits did you find the TG most helpful with? In what ways?
- Artifacts from *Star Wars*
- Artifacts from Real World
- Hands-on activities

6. When you were in the gallery, what did you find difficult or problematic in using the TG?

7. In total, how many TG stops do you think you saw? _____(/22) *(Probe: If under 10, what made you decide not to see more?)*

8. Did you bookmark any information to send home?

YES	NO
a.) What made you decide to bookmark?	a.) Did you know about the bookmarking feature? Y N
b.) What types of information did you bookmark?	b.)What made you decide not to bookmark?
c.) What types of information do you expect to receive?	c.) What would have made you decide to bookmark?
d.) How difficult did you find entering your email address?	

9. In retrospect, what did you learn from the TG that you didn't know before?

10. Now moving forward, what ideas or suggestions do you have for future TG at the MoS?

11.) **How often do you use audio tours in other museum exhibitions (when they're available)?**
a.) Never b.) Once or twice c.) I sometimes use them d.) I usually use them e.) I always use them

12.) **Who in your group used the multi-media tour? (circle all that apply):**
a.) All group members b.) Just the adults c.) Just the children d.) Just me e.) Other (explain): _____

13.) **While using the multi-media tour, did the members of your group interact with each other**
a.) More b.) Less c.) The same than you would have without the tour

14.) **How likely would you be to use a MMTG for the rest of the Museum, if one were available?**	Not at all likely 1 2 3 4 5 6 7 8 9 10 Very likely

_____

15. Please tell us a little bit about yourself:

Age:
a. Under 18
b. 18-24
c. 25-29
d. 30-34
e. 35-44
f. 45-54
g. 55-64
h. 65-74
i. 75-84
j. 85+

Gender:
a. Male
b. Female

Are you a MOS member?
a. Yes
b. No

Before today, when did you last visit the Museum of Science?:
a. First-time visitor
b. Within the last 3 months
c. 3-6 months ago
d. 6 months to a year ago
e. 1-2 years ago
f. 2-5 years ago
g. 5-10 years ago
h. more than 10 years ago

Including today, how many times have you visited? _____

Who did you visit the *Star Wars* exhibit with?:
a. Family group with children under 18
b. Adults-only group (18+)
c. With your class/school group
d. By yourself
e. Other: _____

How often do you visit our web site (www.mos.org)?
a. Never
b. Occasionally
c. Monthly
d. Weekly
e. Daily

Do you (or does a member of your group) have a permanent or temporary disability? Y N If yes, please indicate which type (circle all that apply):
a.) mobility b.) emotional c.) cognitive d.) visual e.) auditory f.) learning g.) other:_____

Please rate these characteristics as they apply to you:

a.) Interest in learning about science and technology	Not at all interested 1 2 3 4 5 6 7 8 9 10 Very interested
b.) How much of a *Star Wars* fan are you?	Not a fan at all 1 2 3 4 5 6 7 8 9 10 Very big fan

Book give-away! Enter a raffle if phone interview. *Y* *N*

APPENDIX E NON-MMT USER QUESTIONNAIRE

1. On a scale of 1 to 10, where 1 is not at all satisfied & 10 is very satisfied, how satisfied were you with the *Star Wars* exhibit?

2. As you were going through the exhibit, what questions did you have about anything you saw/learned? (*What questions did the exhibit raise for you?)*

3. In what things or topics did the exhibit spark your interest? *(After viewing the exhibit, what things have become more interesting to you?)*

4. How likely will you be to explore further the questions or topics raised by the exhibit once you get home?
Not at all likely Somewhat unlikely Somewhat likely Very likely

5. Were you aware that the Museum offered a multi-media handheld PDA tour guide with the *Star Wars* exhibit? N Y
If Y -> I noticed that you don't have one. **What made you decide not to get it?** *(If children cited as reason, probe → What type of MMT could we provide that would be family/child friendly or that you would rent when you're with your child(ren)?)*

If N -> **If you had known about it, would you have decided to rent it?** Why? Why not?

Even though you didn't rent the tour guide, the Museum is interested in developing TGs that would appeal to a broad range of visitors. Your answers to the next few questions could help us do that.
6.What types of things would you guess that the multi-media handheld PDA tour guide has on it?

7. If you had rented the multi-media handheld PDA tour guide, what do you think you might have gotten from it?

8. For you to decide to use a MMTG, what would it need to be like? *(*Probe for details: Describe to me your ideal MMTG for the Museum of Science – how would it work? What features and content would it have?)

9.) Describe to me what multi-media tour guides in museums of the future might be like. *(Complete this sentence: It would be cool if the museum could offer tour guides that _____")*

10.) **How often do you use audio tours in other museum exhibitions (when they're available)?**
a.) Never b.) Once or twice c.) I sometimes use them d.) I usually use them e.) I always use them

11.) **How likely would you be to use a MMTG for the rest of the Museum, if one were available?**

Not at all likely 1 2 3 4 5 6 7 8 9 10 Very likely

Demographics

Please tell us a little bit about yourself:

Age:
k. Under 18
l. 18-24
m. 25-29
n. 30-34
o. 35-44
p. 45-54
q. 55-64
r. 65-74
s. 75-84
t. 85+

Gender:
a. Male
b. Female

Are you a MOS member?
a. No
b. Yes

Before today, when did you last visit the Museum of Science?
a. First-time visitor
b. Within the last 3 months
c. 3-6 months ago
d. 6 months to a year ago
e. 1-2 years ago
f. 2-5 years ago
g. 5-10 years ago
h. more than 10 years ago

Including today, how many times have you visited? _____

Who did you visit the *Star Wars* exhibit with?
a. Family group with children under 18
b. Adults-only group (18+)
c. With your class/school group
d. By yourself
e. Other: _____

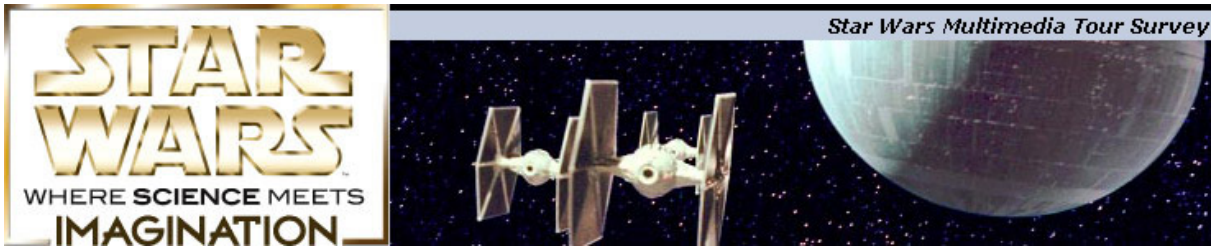
How often do you visit our web site (www.mos.org)?
a. Never
b. Occasionally
c. Monthly
d. Weekly
e. Daily

Do you (or does a member of your group) have a permanent or temporary disability? N Y If yes, please indicate which type (circle all that apply):
a.) mobility b.) emotional c.) cognitive d.) visual e.) auditory f.) learning g.) other:_____

Please rate these characteristics as they apply to you:

a.) Interest in learning about science and technology	Not at all interested 1 2 3 4 5 6 7 8 9 10 Very interested
b.) How much of a *Star Wars* fan are you?	Not a fan at all 1 2 3 4 5 6 7 8 9 10 Very big fan

APPENDIX F BOOKMARK USER QUESTIONNAIRE



1 of 5

Your feedback is very important to us!

Thank you for visiting the Museum of Science's ***Star Wars: Where Science Meets Imagination*** bookmarks website. This is the first time the Museum of Science has used a Multimedia Tour with bookmarking features, so we are very interested in hearing your thoughts.

Complete this short survey and enter to win an autographed copy of the ***Star Wars: Where Science Meets Imagination*** book, created by the Museum of Science and National Geographic as a companion to the exhibit!

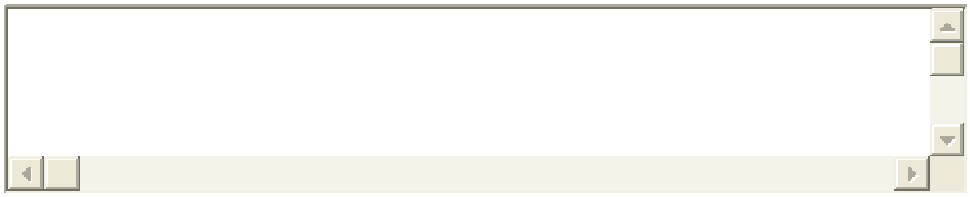
1. On a scale from 1 to 10, how much did you enjoy the following:

	I didn't enjoy it at all									**I enjoyed it a lot**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
a. *Star Wars* exhibit	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. Multimedia tour	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. Bookmarked webpages	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

2. On a scale from 1 to 10, how much did you learn from the following:

	I didn't learn anything									**I learned a lot**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
a. *Star Wars* exhibit	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. Multimedia tour	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. Bookmarked webpages	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3. What are some things you remember best about the exhibit? (Type your response below.)

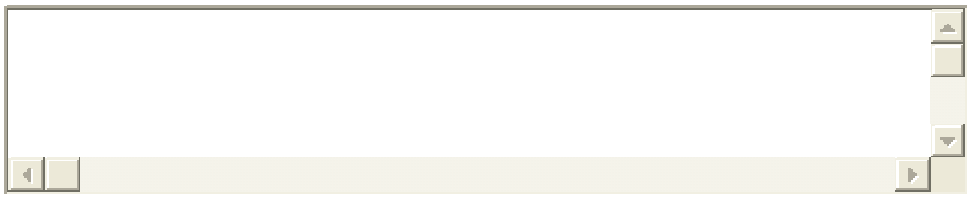


2 of 5

4. On a scale from 1 to 10, how useful were the following Multimeda Tour features to you?

	Not useful at all									**Very useful**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
a. Bookmarking websites to learn more at home	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. Multimedia features (e.g., video, audio)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. American Sign Language tour	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Text captioning	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. Getting more in-depth information about *Star Wars*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Getting more in-depth information about technology and science	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5. What ideas, comments or suggestions do you have for future multimedia tours at the Museum of Science? (Type your response below)



6. On a scale from 1 to 10, how useful were the following bookmark page features to you?

	Not useful at all 1	2	3	4	5	6	7	8	9	**Very useful to me** 10
a. Ability to learn more about the exhibit at home	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. Content of the bookmarked pages	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. Ability to forward webpages to friends	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Links to related websites	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. Video interview clips	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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7. Tell us about yourself!

a. On a scale from 1 to 10, rate your interest in learning about science and technology.

Not interested at all									Very interested
1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

b. On a scale from 1 to 10, how much of a *Star Wars* fan are you?

Not a fan at all									A very big fan
1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

c. How often do you use audio tours in other museum exhibitions?

☐ Never

☐ I've used them once or twice

☐ I sometimes use them when they're available

☐ I usually use them when they're available

☐ I always use them when they're available

d. Over the years, how many times including your visit to see *Star Wars*, have you been to the Museum of Science, Boston?
If this was your first visit, please write a 1 and skip the next question.

e. Before coming to the *Star Wars* exhibit, when was the last time you visited the Museum of Science, Boston?

- Within the last 3 months
- 3-6 months ago
- 6 months to within the last year
- 1-2 years ago
- 2-5 years ago
- 5-10 years ago
- More than 10 years ago
- Not sure

f. How often do you visit the Museum of Science's website, www.mos.org?

- This is my first time
- Daily
- Twice a week
- Three times a month
- Rarely

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g. Are you a member of the Museum of Science, Boston?

Yes No

h. What is your gender?

Male Female

i. What is your age?

- [ ] Under 18
- [ ] 18-24
- [ ] 25-29
- [ ] 30-34
- [ ] 35-44
- [ ] 45-54
- [ ] 55-64
- [ ] 65-74
- [ ] 75-84
- [ ] 85 or older

j. Who did you visit the *Star Wars* exhibition with?

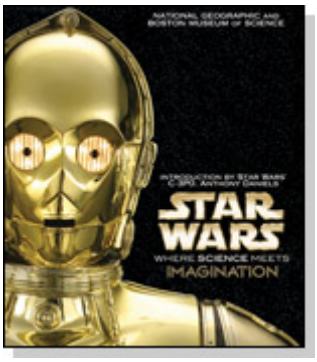
- [ ] Group with children under 18
- [ ] Adults-only group (18+)
- [ ] By myself
- [ ] School field trip
- [ ] Other:

k. Do you have a temporary or permanent disability?

- [ ] No, I do not have a temporary or permanent disability
- [ ] Yes, I have a temporary or permanent disability

l. If you do have a temporary or permanent disability, what kind is it? [Select all that apply]

- [ ] Not applicable (N/A)
- [ ] Mobility
- [ ] Emotional
- [ ] Cognitive
- [ ] Visual
- [ ] Auditory
- [ ] Learning
- [ ] Other:



If you'd like to be entered into a drawing for a signed copy of the ***Star Wars: Where Science Meets Imagination*** book by National Geographic in association with the Museum of Science, please enter your contact information.

All information you provide will be kept confidential and will not be shared with anyone other than the Museum of Science Research Department. Your personal information will not be associated with your survey responses.

If you are not interested in entering to win the book, leave this page blank and press the **Finish** button below.

Full Name:

Email Address:

Phone Number:

Address:

City/Town:

Zip Code:

APPENDIX G CASE STUDY OBSERVATION PROTOCOL

Protocol for Star Wars Multimedia Tour Case Study Observations

Approach

Wait for an individual to approach Antenna to pick up MMT. Approach individual and explain role: "I work here at the Museum. We're interested in finding out visitors' experience in the exhibition with the handheld so I am accompanying visitors unobtrusively on their visit through the gallery to see what their experience is like. I'll be largely unobtrusive – I'll be peering over your shoulder and at the end, will have a few questions. If you are willing to let me follow you, I can offer you general admission tickets for future use and Omni tickets or a free PDA if have not already purchased (Note: This is a subset of individuals who have already purchased PDAs with their admission ticket.).

a. Alternatively, for the non-PDA user, if they are waiting in line, approach the individual and say I work for the Museum, and we are interested in trying to see what a visitor's experience is like in this exhibition.
b. If visitors agree – Just to clarify, I'll be peeking over your shoulder. You should go through the exhibit as you normally would, as if I weren't there. If you do have any thoughts, questions or feedback, feel free to share them with me as they come up when in the exhibit. If you start feeling uncomfortable, we can stop at any time – just let me know.

Target Participants

Based on the make-up of the *Star Wars* interviews, it would be ideal that the make-up of our interactive observations for each PDA and non-PDA user group would be:

1 person Under 18
1 person 25-29
2 people 45-54
1 person? 65-74

By group type, they might be broken up by:

3 family groups
2 adults-only groups

<u>Observation Questions</u>

- Social interactions
  - Do they stay together or split up?
  - How often do they converse with members of their social group?
  - What is the nature of the conversation of their social group's interactions?
  - (How often do they converse with me?)
- Types of gallery exhibits they visit and use the MMTG with
  - Interactives
  - SW artifacts

    - o
    - RW artifacts
- Features/Content used on the TG
    - Behind the Scenes
    - Bookmarking

- What exhibits do visitors visit? Which do they use the MMTG?
- When do they stop using the MMTG?

Notation Style

Raw/Observational – who goes where, what they watch
Exact – what types of things said

Interview

[Same questions as interview guide]

- What made you decide to rent the TG?
- What aspect of the TG did you find most compelling?
- The TG had SW film clips, behind the scenes interviews with *Star Wars* producers, descriptions of real world objects/phenomena, and photos of real world objects. What content did you like most?

[In addition:]

- Specific questions about observations – what I noticed
- On a scale from 1 to 10, how much did having me with you during your visit, change your exhibit experience?

APPENDIX H ASL FOCUS GROUP DOCUMENTS

ASL FOCUS GROUP (12/3, 12/10)

Thanks for coming to see the *Star Wars: Where Science Meets Imagination* exhibit and to give feedback about our ASL Multimedia Tour. Here is today's schedule:

10AM *VISITOR ARRIVAL*

- Sign-in, get visitor sticker
- Get parking validation.
- Get: schedule, map in case you become separated from group, and free admission tickets to *Star Wars*.

10:15AM ***STAR WARS* EXHIBIT**

- As a group, walk to exhibit. Get ASL Multimedia Tour outside exhibit. This is the first time we're using the ASL Tour!
- Spend up to 90 minutes visiting the exhibit. Explore the exhibit as you normally would. If you finish earlier, you can leave the exhibit and explore other parts of the Museum – but you cannot re-enter the *Star Wars* exhibit. If you need to go to the bathroom, ask staff for a pass.

11:45AM **MEET IN LOBBY.**

- Regroup and head to Test Tube, Blue Wing 2nd floor.

12PM *BEGIN FOCUS GROUP ON ASL-MULTIMEDIA TOUR*
in Test Tube, Blue Wing 2nd floor, next to the Butterfly Garden

- Tell us your thoughts on the Tour – what did you like? What didn't you like? We'll ask you several questions.
- Today's **interpreters** are: Mr. Chris Robinson & Ms. Aimee Schiffman

1PM **THANK YOU!**

- Receive free admission passes to the exhibit hall (*Note: You may use your exhibit hall pass for up to a year. You can get in to the exhibit halls free today with the visitor sticker.)

If you have any questions, please contact Elissa Chin (echin@mos.org), Sr. Research/Evaluation Assistant, or Christine Reich (creich@mos.org), Manager of Informal Education Research/Evaluation. Our TTY phone numbers are: (617)589-0480

Star Wars ASL Multimedia Tour Survey

Gender: M F
Age:

On a scale from 1 to 10, how interested are you in learning about science and technology?

1	2	3	4	5	6	7	8	9	10
Not at all interested									Very interested

On a scale from 1 to 10, how much of a *Star Wars* fan are you?

1	2	3	4	5	6	7	8	9	10
Not a fan at all									A very big fan

What percentage of time did you spend using the Multimedia Tour when in the *Star Wars* exhibit?

- ❑ 25% or less
- ❑ 26-50%
- ❑ 51-75%
- ❑ 76-100%

How often do you visit museums?

- ❑ Multiple times a year
- ❑ Once a year
- ❑ Once every couple years
- ❑ Rarely
- ❑ Never

What are your impressions of the Museum of Science <u>as a welcoming place for deaf visitors</u>?

Do you have any other comments you'd like to add?

Deaf Focus Group Protocol

Welcome Key Points

- We are from the Research/Evaluation Department, what we do, introduction of team, interpreters
- Commitment to universal design - SW evaluation
- This is the first time the Museum of Science has ever used an ASL-Multimedia Tour. We didn't design it, can't fix it right away, but want to inform future designs.
- Focus group background – one person speaks at a time (to record things), honest conversation – so both positive and negative comments, would love to hear from everyone.
- (Quickly introduce focus group members, favorite part of the exhibits)

Questions:

About the Exhibit

- Overall impressions of exhibit

About the Multimedia Tour

1. **Tell me what you think overall about the Multimedia Tour.**

- Like most about Tour?
- Like least?
- What learned didn't know before from Tour?

2. **Coming into the exhibition, what were your expectations of the Multimedia Tour?**

- Expectations of Tour
    - Features
    - Content
    - Interface
    - Overall Value
- Meet or not meet expectations?

3. **If you didn't have the Multimedia Tour, how do you think your experience in the exhibit would be different, if at all?**

- Artifacts
- Interactives
- Content
- Welcoming atmosphere at exhibit overall?
    - Enjoyment level
    - Learning level
- Staff
- Social interactions – positive vs. negative ways?
    - Nature
        - Coming by self vs. with friends
    - Quality (depth)
    - Frequency
- Bookmarked information
    - Everyone know about feature?
    - Kinds of information bookmarked
        - Frequency of bookmarks

    - Expectations of info sent home
        - Forms/Media
        - Depth
    - Decisions not to bookmark information
    - Continue to learn about technologies
- What do you think your experience would have been like without the Multimedia Tour? Tell me how you imagine that experience to be like.

4. What would you change about the ASL Multimedia Tour?

- Problems/difficulties faced
    - Ease of finding Multimedia Tour stops
    - Interface
- Improvements for future exhibitions
- Usage in rest of the museum, other exhibits
    - What content want

5. *What can we do to make the Museum of Science a more welcome place for deaf people?*
    - How should we be marketing the Tour to the Deaf Community?
    - How would the deaf community respond to the Museum of Science having an ASL Tour?
    - Have you used a similar tour in other museums or places before? Were they equipped with ASL? Designed for deaf people? Tell us about your experiences.

6. I have some questions about your experience overall in the exhibit.

- Role of crowding
- Magnitude/Role of Tour in exhibit experience
- Additional comments?