Remedial/Summative Evaluation of

THE BIOMEDICAL TECHNOLOGY *EXHIBITION*

for

The Great Lakes Science Center, Cleveland

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EXECUTIVE SUMMARY

Introduction. *Bio Med Tech: Engineering for Your Health* was a 2,750 square foot exhibition at the Great Lakes Science Center (GLSC) that dealt with issues related to biomedical technology. Partially funded by a grant from the National Institutes of Health Science Education Partnership Awards program (NIH/SEPA), the *Bio Med Tech* exhibition represents the rethinking and redevelopment of GLSC's earlier exhibition about medical technology. The project was developed through a partnership between GLSC and Case Western Reserve University (CWRU). The SEPA grant also funded a variety of programming activities, including informal *Exploration Cart* activities in the exhibition, presentations in the exhibition's theater space, and teacher training. The project was targeted particularly at children in middle school and above and at adults, although the team realized they would also need to engage younger children within the exhibition.

Goals of the *Biomedical Technology* project. The project team developed the *Bio Med Tech* exhibition around the following main message that "Rapidly advancing biomedical technologies give doctors new tools to improve personal and public health." The goals for the exhibition addressed four themes: (1) the rapid advances made by biomedical technology researchers in a wide range of fields; (2) the broad range of professions that contribute to advances in biomedical technology; (3) the development of new biomedical technologies in Cleveland, at places like Case Western Reserve University; and (4) the range of visitor opinions about controversial topics related to biomedical technology.

Description of the *Biomedical Technology* exhibition. The exhibition included an entrance area that focused on Cleveland connections and historical advances for biomedical technology and major sections dealing with six topics: Medical imaging, infectious diseases, prosthetics, Functional Electrical Stimulation (FES), stem cells, and genomics. Each section included a mix of graphics panels, multimedia presentations, interactive exhibits, and examples of medical devices. In addition, the exhibition included a multimedia theater (with benches and projection/sound system), where videos were shown continuously, and bulletin boards for news updates and visitor responses to questions about controversial issues in biomedical technology.

Overview of the evaluation. As part of the *Biomedical Technology* project, GLSC was interested in assessing the effectiveness of the exhibition at achieving its original goals. Selinda Research Associates, Inc. (SRA) was brought on to complete a multi-stage evaluation. This report describes the findings and recommendations of the remedial/summative evaluation of (a) the *Bio Med Tech* exhibition and (b) selected programming in support of the exhibition's goals during the study. The research question for this study was, "In what ways and to what extent did the *Bio Med Tech* exhibition and programming achieve the project's four major visitor goals?"

Methodology and methods. This evaluation study used a naturalistic inquiry methodology, which is an ethnographic and primarily qualitative approach to understanding visitors and museums. Data were collected from a variety of sources and triangulated to develop a thorough understanding of the effectiveness of the project at achieving its goals. Data was collected in the exhibition on three two- to four-day site visits during winter and spring, 2008. On-site data

collection used five primary methods: (a) unobtrusive observations, (b) intercept interviews, (c) exit interviews, (d) participant observations, and (e) a written survey to solicit responses after *Bio Med Tech* theater presentations. Respondents included both casual visitors to the exhibition and members of school and scout groups. In all, SRA staff spent about 50 visitor contact hours in the exhibition, which included time for observing and interviewing visitors and for debriefing about the resulting data. Including all methods of data collection, there were 483 individual respondents from 130 respondent groups. Data analysis for this study was an on-going process using a modified inductive constant comparison approach (Lincoln & Guba, 1985).

Overall *Bio Med Tech* experience. The *Bio Med Tech* exhibition provided an enjoyable learning experience for many, but not all, visitors in the target age ranges. Many respondents in the target age ranges were engaged with the graphic/text panels, multimedia components, and interactives. For middle and high school students, the interactive exhibits proved particularly engaging. Visitors connected most readily to the personal aspects of *Bio Med Tech*, articulating a range of personal connections with the many medical devices and procedures on display and often sharing these connections with others in their groups. Because adult visitors were more likely than younger visitors to engage with the graphic/text panels, younger visitors learned more when an adult was guiding their experience. Respondents who worked in health care fields often discussed their professional experiences with others in their groups. Younger visitors who were already interested in human biology and/or were considering health care as a career showed deeper interest in the *Bio Med Tech* exhibition and engaged with more elements of the exhibition.

What visitors gained from their experiences. Most respondents in the summative study were able to describe something they had found out in the exhibition that was new and interesting to them. The exhibition made some respondents aware of new areas of medical technology, while other respondents filled gaps in their knowledge or discovered surprising connections between technologies. Many respondents walked away with memories of the experience itself; they were able to visualize medical technologies in ways they had not been able to before. Children sometimes learned more about the human body than about biomedical technologies.

Achieving *Bio Med Tech* goals. The exhibition was partially successful at achieving its four main goals. It was most successful with the **advances in biotechnology** goal. Most adults and many older teens recognized this as the exhibition's theme and enthusiastically recalled specific advances they had read or heard about in the exhibition. However, the term "biomedical technology" was rarely used by respondents; they more often used terms like science, research, medicine, and/or technology as they described the advances. Some teens and most younger children paid little attention to the larger themes of the exhibition, focusing instead on the human body itself, what can go wrong with it, and/or on the technologies that can see inside or repair the body.

Looking at two other major goals of the exhibition, most respondents said they had learned little about either biomedical **technology professions** or the prevalence of **biomedical research and development in the Cleveland area**. Because the exhibition addressed these goals in only a few

places, many respondents said they had not noticed that these topics were discussed in the exhibition.

Looking at the fourth major goal, respondents' perceptions about **controversial topics** in *Bio Med Tech* centered on two sections of the exhibition: The "Share Your Thoughts" bulletin board and Stem Cells section. Many respondents expressed surprise at the range of responses that were posted on the "Share Your Thoughts" board, and most also expressed tolerance for but not complete acceptance of this range of views. In other words, the bulletin board was more a test of visitors' respect for other visitors' opinions, rather than evidence that GLSC respected visitors' opinions about controversial topics related to biomedical technology. Most respondents said they considered the *Bio Med Tech* presentation about stem cells to be informative, balanced, and providing a viewpoint that helped them put the controversy in perspective; none said they felt the exhibit did not respect their own opinion.

Effectiveness for different sorts of visitor groups. The effectiveness of the *Bio Med Tech* exhibition varied for different visitor groups based on three interrelated factors: Learning style preferences of group members; type and degree of interest and personal connections that respondents felt to the topics covered in the exhibition; and interpretive and meditative skills of visit facilitators (who were often parents or peer-group leaders). These three factors help explain why many families with younger children or teens left *Bio Med Tech* after a short visit, and why large groups with middle and high school students tended to split up when they encountered *Bio Med Tech*. Most of these students left after a few minutes with the interactive components, while smaller groups of students with a strong existing interest in human biology, engineering, or health care professions stayed behind to explore all aspects of the exhibition. These factors also explain why *Bio Med Tech* was particularly effective for couples. Many couples walked through the exhibition together, sitting side by side at the interactive components, and sharing their interests, experiences, and individual expertise in health science or technology. Given that many GLSC visitor groups included young children and teens, it was not surprising that *Bio Med Tech* was often sparsely populated compared to some other areas of the building. Because couples and other adult groups stayed longer than many other groups, there was often a higher ratio of couples/adults to family/school groups in *Bio Med Tech* than elsewhere in the Science Center.

Effectiveness of exhibition components. Individual exhibit units varied in their success at achieving their stated goals and communicating their intended messages. The Medical Imaging, Prosthetics, and FES exhibits were relatively successful for all ages of visitors, and the Stem Cell exhibits were effective for most adults and many older teens. The Genomics and Infectious Disease sections were less effective for most visitors. The goals of exhibit sections were more often achieved when the goals were concrete and only a step or two beyond what most visitors already knew. Exhibits were also more effective when goal-related messages were communicated through a range of media, including hands-on and interactive exhibits, concrete examples of biomedical technologies, and visitor-controlled multimedia. The report discusses findings related to each exhibit section so that recommendations can be developed for remediation and so lessons learned can be applied to future exhibitions at GLSC.

Contributions of programming. The *Exploration Carts* added much appreciated opportunities for hands-on and interactive experiences to the *Bio Med Tech* exhibition. The three *Cart* programs developed during data collection demonstrated increasing support for the exhibition's major themes and were increasingly effective as entry points to the rest of the exhibition. Public programming in the *Bio Med Tech* theater also provided strong support for the exhibition's themes. The audiences were drawn almost exclusively from the visiting public who had come to GLSC that day for other purposes. The three programs included in this evaluation varied in their presentation styles and in their success at engaging the complex audience that they attracted. Factors that contributed to the success of theater programs included coaching of the speakers, inclusion of hands-on and interactive experiences during and after the presentations, and effective orientation of visitors who join the presentations in progress.

Discussion: Exhibits as information. Quite a few adult respondents really enjoyed the graphics panels in *Bio Med Tech* and said they preferred this exhibition to more interactive spaces elsewhere in GLSC. However, these visitors often requested even *more* information. One problem with providing more depth would be that the text-and-graphics panels would be longer, more difficult to read, and more intimidating for the majority of visitors. Also, several thoughtful respondents pointed out that there was no way *Bio Med Tech* could compete with the Internet (or other in-depth references) as a source of information. The report considers the question, "What is the value of constructing exhibits with large numbers of text-and-graphics panels in the age of the Internet?" It then suggests points to keep in mind when developing future GLSC exhibitions.

Conclusion. The *Bio Med Tech* exhibition was partly successful at achieving both its overall goals and the goals for individual sections of the exhibition. It was most successful at achieving goals related to advances in biomedical technology, in part because this theme was reiterated throughout the exhibition. It was less successful at achieving other main goals, in large part because these were communicated in only a few parts of the exhibition.

Lessons learned and recommendations. The final section of the report discusses lessons that the researchers learned through this summative evaluation study, including lessons related to biomedical technology exhibits and more general lessons about the exhibit development process. It also makes a range of recommendations for improving the overall effectiveness of the *Bio Med Tech* exhibition at achieving its goals and for improving the effectiveness of individual exhibits. Finally, the report includes suggestions for developing future exhibitions at GLSC.

INTRODUCTION

Bio Med Tech: Engineering for Your Health was a 2,750 square foot exhibition at the Great Lakes Science Center (GLSC) that dealt with issues related to biomedical technology. It was developed by GLSC's *Biomedical Technology* project[1] team with a grant from the National Institutes of Health Science Education Partnership Awards program (NIH/SEPA). In addition to the *Bio Med Tech* exhibition, the grant also funded a variety of programming activities, including informal *Exploration Cart* activities in the exhibition, presentations in the exhibition's theater space, and teacher training.

Selinda Research Associates, Inc. (SRA) contracted with GLSC to complete a multi-stage evaluation for the *Biomedical Technology* project. This report describes the findings and recommendations of the remedial/summative evaluation of (a) the *Bio Med Tech* exhibition and (b) selected programming in support of the exhibition's goals during the study.

Background

The *Bio Med Tech* exhibition represents the rethinking and redevelopment of an existing exhibition about medical technology, which had been installed when GLSC opened ten years before the initiation of this project and had not been updated since. The new exhibition was developed through a partnership between GLSC and Case Western Reserve University (CWRU). The GLSC project team worked with an advisory group of CWRU biomedical technology specialists to develop the goals, topic areas, and interpretive messages for the exhibition. CWRU professors consulted on potential topics, provided information to exhibition developers, and reviewed proposed plans and interpretation for the exhibition. In addition, several CWRU professors participated in programming in the exhibition, including presentations for both educators and the public. The exhibition was designed by Quatrefoil, an exhibit design firm from Laurel, Maryland, which worked in close collaboration with GLSC's exhibition team.

The exhibition was targeted particularly at children in middle school and above and at adults, although the project team realized they would also need to engage younger children within the exhibition.

Goals of the Biomedical Technology *Project*

The GLSC project team developed the *Bio Med Tech* exhibition around the following main message or big idea:

> *Rapidly advancing biomedical technologies give doctors new tools to improve personal and public health.*

[1] Notes on terminology. This report uses "*Biomedical Technology* project" to refer to the overall project funded by NIH/SEPA, including both the exhibition and programming. The name "*Bio Med Tech*" is reserved for just the exhibition. The term "exhibition" refers to the entire *Bio Med Tech* gallery, and "exhibit" to individual components within the gallery.

The overall goals for the exhibition were:

1. *Visitors will be amazed at the rapid advances that biomedical technology researchers are making in a wide range of fields.*
2. *Visitors will gain perspective on the broad range of professions that contribute to advances in biomedical technology.*
3. *[Cleveland-area] visitors will feel proud that so many new biomedical technologies are being developed right here in Cleveland, at places like Case Western Reserve University.*
4. *Visitors will appreciate that GLSC respects their opinions about controversial topics related to biomedical technology.*

Description of *Biomedical Technology* Project

Bio Med Tech *Exhibition*

This section includes brief descriptions of the major exhibits within the *Bio Med Tech* exhibition. The photographs referred to in the text are in Appendix A: Photographs of the Exhibition and Programming. The goals and messages included in this discussion were extracted from a project team document, Bio Med Tech *Exhibition Outline*, dated November 28, 2007.

The gallery in which the *Bio Med Tech* exhibition was located was on the first floor of the GLSC, and the exhibition opened to the building's core along its entire north wall.[2] The **entrance area** included two half-height wall segments that partially isolated the exhibition from the core (Figs. A-1 and A-2) and a central "island" located just inside the gap between these walls (Figs. A-4 and A-5). The exhibition's credit panel, on the east wall just outside the entrance, listed the partners in the *Biomedical Technology* project, including Case Western Reserve University and local biomedical technology companies (Fig. A-3). The stated goals of the entrance exhibits were to "amaze visitors with improvements in biomedical technologies" and to inspire Cleveland-area visitors to "feel proud that so many new biomedical technologies are being developed right here in Cleveland, at places like Case Western Reserve University." The exhibits' primary messages were that biomedical technologies have improved radically in recent years, and that Cleveland-area researchers and research institutions have made significant contributions in developing these technologies.

On the west side of the broad entrance to the gallery was a series of exhibits about **medical imaging** (Fig. A-6 to A-8). The goals of these exhibits were to "amaze visitors with the ways in which biomedical technology researchers are improving medical imaging devices" and to "surprise them with the many new applications doctors are finding for advanced medical imaging devices." The exhibits were designed to impart four major messages:

- *Biomedical technology researchers have made amazing improvements in the speed, definition and accuracy of medical imaging devices.*
- *Imaging devices are used not only to diagnose but also to treat patients.*

[2] For consistency and continued relevance of the report as the exhibition continues to evolve, exhibition descriptions and research findings are all written in the past tense.

- *Modern medical imaging devices provide diverse and striking depictions of internal anatomy.*
- *Each type of imaging device excels at showing a different kind of structure, tissue, or pathology.*

To communicate these messages, the medical imaging section included numerous examples of images taken using a variety of advanced technologies. Many images were displayed on graphics panels (e.g., Fig. A-8), but others were accessed by visitors using interactive devices. These included an actual example of an open MRI, where visitors could select from a series of diagnostic images on a computer monitor mounted on a table in front of the machine (Fig. A-6, center); a functioning endoscope, where visitors could push a button to insert an endoscopic camera into a preserved pig's stomach and intestine, viewing the results on an overhead monitor (Fig. A-6, left); and a CT scan "spinner," where the rotary control allowed visitors to display a series of diagnostic CT scan images on a monitor, moving through them at their own pace (Fig. A-7).

In the southwest corner of the gallery were several exhibits related to **infectious diseases** (Fig. A-9). The goals for this area were to help visitors appreciate the many ways that biomedical technology is contributing to the diagnosis and treatment of emerging infectious diseases, and to help visitors better understand factors affecting risk of contracting various infectious diseases. The text and graphics panels focused on the messages about the applications of advances in high-speed computing to improve treatment of infectious disease and about how advanced imaging devices help researchers identify infectious diseases. The label text also discussed how teams of researchers from different disciplines work together to solve problems related to infectious disease. This section included a prototype version of an *Investigation Station* (Fig. A-10), where pairs of visitors challenged each other to solve medical mysteries using activity cards that listed clues to the identification of agents that caused various diseases in hypothetical patients.

In the center of the south wall of the gallery was the ***Bio Med Tech* theater** space. This space was partially blocked off from the adjacent exhibits by low walls on two sides, and it included several benches (Fig. A-11). The theater served two functions: Most of the time looped videos were projected onto the theater's screen, but once or twice a month it was used for special presentations (described in the section Biomedical Technology Programming in the Exhibition, below). A computer-controlled projection and sound system was included as part of this space. During data collection, two different videos were shown. During January and February visits, the video was a GLSC-produced series of images related to the exhibition, played without music or accompanying narration or on-screen text. Many of the images were from advanced imaging techniques displayed in the exhibition, like CT and MRI; other images were related to other parts of the exhibition, like prosthetics or infectious diseases. A second video, shown during the April site visit, was a *Science Bulletin* segment produced by the American Museum of Natural History, distributed to museums throughout the United States. The segment shown in April was the *Human Bulletin*, dated March 2008, with discussions about malaria (including a new global map of where malaria occurs) and the Flores fossil humans. This video included sound but no spoken narration.

Opposite the theater, on the back of the entrance island, were two **bulletin-board** panels (Fig. A-12). The board on the left was entitled *Recent Breakthroughs*. During data collection, there was a single article posted on the board (a year-end review of medical advances reproduced from *Parade* magazine). The board on the right was a "talk-back" board, entitled *Share Your Thoughts*, where visitors could post their responses to questions posed by GLSC (Fig. A-13). This approach reflected the fourth major goal of the exhibition: "Visitors will appreciate that GLSC respects their opinions about controversial topics related to biomedical technology." Two questions were rotated in during data collection. During the January and February visits, the question was:

Researchers are testing brain implants that
could detect and predict epileptic seizures, treat
depression, return movement to paralyzed muscles
or control prosthetic limbs or wheelchairs.
What else do you wish they could do?

The new question for April was:

If scientists could design children's genes,
what traits would you allow them to choose?

Visitors wrote their responses on yellow sticky notes and posted them on the board. GLSC staff members periodically culled the responses, creating room for new responses by disposing of irrelevant responses but always leaving at least a few on-target notes on the board.

In the southeast corner of the gallery were several exhibits about **prosthetics** (Fig. A-14). The goals of these exhibits were to help visitors understand what prosthetics and implants are and to help them appreciate how biomedical technology researchers are making prosthetics and implants more effective and comfortable for patients. Exhibit messages discussed how prosthetics and implants are engineered to replace missing or damaged body parts and how biomedical technology researchers are developing more sophisticated prosthetics and implants that include microprocessors, advanced biomaterials and/or living cells to enhance their function. This area also included a prototype *Investigation Station* were visitors could use a joystick-like device to control a prosthetic arm (left side of Fig. A-14).

Also in the southeast corner of the gallery, opposite the prosthetics exhibits, were several exhibits about **Functional Electrical Stimulation**, often referred to by the initials **FES** (Figs. A-15 and A-16). The goals of these exhibits were that visitors would:

- *understand what FES is and what it can accomplish for patients who have lost the use of their muscles.*
- *experience empathy for the patients and appreciation for the ingenuity and industriousness of FES researchers.*
- *realize that developing FES technologies requires a team of specialists.*

Educational messages defined FES as a type of biomedical technology that offers people who have impaired movement improved control of their muscles and pointed out that biomedical technology researchers are constantly scouting smaller batteries, advanced materials, and faster microchip technologies to make FES better.

Several exhibits about **stem cells** occupied the center of the east wall and an adjacent island (Figs. A-18 to A-20). The goals of these exhibits were to help visitors understand the different types of stem cells and the roles they play in healing the body and to help visitors gain new perspectives on some of the more controversial aspects of stem cell research. The educational messages focused on defining types of stem cells and correcting misperceptions about stem cell technology:

- *At every age, people have stem cells that help repair damaged tissues.*
- *Biomedical technology researchers are searching for ways to direct and extend stem cells' healing ability.*
- *Stem cells are the source of the cells that make up the human body; fixing or replacing the stem cells is a way to treat some cell-based diseases, such as sickle cell anemia.*
- *Embryonic stem cells and adult stem cells have different capabilities and legal status, and raise different ethical concerns.*
- *Embryonic stem cells are taken from blastocysts created through IVF, 5 to 7 days after fertilization.*

The exhibits in the northeast corner of the gallery focused on **genomics**, the study of the entire DNA sequence, or genome (Fig. A-21). Exhibit goals included helping visitors understand what genomics is and increasing their comfort with some basic terminology and concepts of genomics. Additional goals included impressing visitors with the many ways that genes affect human health and amazing them with recent discoveries in genomics that have already resulted in improved diagnoses and novel approaches to treatment. Educational messages focused on concepts like "genetic screening routinely saves lives of newborns" and on how researchers continue to study how genes work, paving the way to new diagnoses and treatments. This section included a third prototype *Investigation Station* (Figs. A-22 and A-23), where visitors were challenged to match model DNA sequences to see which were predisposed carriers of diabetes.

The computer exhibit, *Health Careers Quest*, was developed as part of the original *Medical Technology* exhibition (Fig. A-24). Two computer stations, built into the module, allowed visitors to explore a range of programs that allowed them to explore careers in medicine and health and introduced them to women scientists.

The exhibition included numerous portable stools (visible in Figs. A-6, A-7, A-9, and so forth). The stools were placed wherever there was a computer screen or other interactive element where visitors might want to sit and spend some time. During data collection, there were enough stools in the exhibition that visitors could pull up two stools at many exhibits and sit side-by-side.

Biomedical Technology Programming in the Exhibition

The *Biomedical Technology* project included a number of programming initiatives aimed at schools, the general public, and at young people who were considering a career in the biomedical technology field. This evaluation report focuses the impact of two types of public programming on the visitor experience in the *Bio Med Tech* exhibition: *Bio Med Tech Exploration Carts* (Figs. A-25 to A-28) and public programming in the *Bio Med Tech* theater (Figs. A-29 and A-30). GLSC staff defined the purpose of these gallery programs as facilitating multiple entry points for visitors to the exhibition. Target audiences for the *Carts* included family and other groups with younger children, although older children and adults were also considered in planning the *Cart* activities. Presentations in the theater were aimed at three different audiences: Students, teachers, and the general public.

There were two *Bio Med Tech Exploration Carts* in use during data collection for the remedial/summative evaluation. Each cart was staffed by trained staff or volunteers. The first cart, rolled out in January, included several activities about DNA (Figs. A-25 and A-27). One relatively simple activity was a model DNA molecule that visitors could twist and untwist, demonstrating DNA's double helix structure (foreground in Fig. A-26 B). A second, more complicated activity, challenged visitors to build a DNA molecule from constituent base pairs (foreground in Fig. A-26 A). A third activity, about genetically determined traits in humans, was developed especially with younger children in mind (Fig. A-27). Visitors selected pairs of cards of a pile, with each pair representing two genes that determined human traits like gender, skin tone, or hair. Based on which cards they selected, visitors would select a paper person (male or female), then draw or color in that person's skin tone, hair, and so forth as determined by the cards. The second cart, developed in February through April, had a medical imaging theme (Fig. A-28). The activity included four closed wooden boxes that each contained an object. Visitors were challenged to identify the object in each box by matching it to an object on the cart (Fig. A28 B). They could use two lines of evidence to make the match: Lifting, tipping, and shaking the box (analogous to the physical exam that was available to the medical doctors in decades past) and looking at CT scan images (similar to those available to contemporary doctors). (In some cases, the physical exam was enough; in others, an image was required.)

There were three *Bio Med Tech* theater presentations during data collection for the remedial/summative evaluation. For each presentation, additional seating was added within the theater space (Fig. A-29), and for some presentations tables were added for use with hands-on activities and demonstrations. All three presentations were by professors affiliated with Case Western Reserve University, including members of the project's advisory team. Each was advertised as a "Biomedical Technology Career Presentation" on a theme portrayed within the exhibition. Science Center visitors could find out about the presentations through a variety of means, including handouts available at the front desk and within the exhibition, temporary signage, and one-on-one contact with museum staff and volunteers. Some presentations were also advertised on the GLSC website and by e-mails to teachers on GLSC e-mail lists. The first presentation, about medical imaging, included a series of PowerPoint images, narrated by the speaker, followed by a question-and-answer period. The second presentation, about prosthetics, included a PowerPoint presentation, followed by a make-it-and-take-it activity (visitors could make a mold of their finger), and finally a demonstration of how an entire human face was

molded. The third presentation, about Functional Electrical Stimulation or FES, began with a PowerPoint presentation and then engaged participants with several hands-on activities, including controlling a remote-controlled car or a prosthetic arm using electrical signals to visitors' arm muscles (Fig. A-30). Each presentation, plus the additional activities, lasted an hour to an hour-and-a-half.

In addition, the *Biomedical Technology* team developed ways to support school teachers' use of the exhibition with their classes, including educator workshops, pre- and post-visit activities, and a health career kit that can be sent to schools. SRA consulted on the development and evaluation of the school programming by producing an annotated bibliography (Gyllenhaal, 2007) and helped GLSC educators develop instruments for continuing use in program evaluation. However, these aspects of *Biomedical Technology* programming were not included in the remedial/summative evaluation study.

Goals of the Evaluation

This report is the culmination of three phases of evaluation. In 2006, SRA conducted an extensive front-end evaluation about what GLSC visitors knew and how they felt about biomedical technology (Gyllenhaal & Ziff, 2006). The front-end report also included a series of mini-evaluations of exhibits in the existing *Medical Technology* exhibition, which the team was considering updating for use in the new exhibition. In 2007, SRA worked closely with the GLSC exhibit developer to carry out a series of formative evaluations of exhibits that were being developed for the new exhibition (Gyllenhaal & Ziff, 2007 a, b, c). When they are relevant to the summative evaluation findings, the results of the front-end and formative studies are cited in the body of this report.

This final evaluation study is a remedial/summative evaluation of the completed exhibition and selected programs that support the exhibition's goals. The research question for this study was:

> *In what ways and to what extent did the* Bio Med Tech *exhibition and programming achieve the four major visitor goals (as outlined above)?*

In order to answer the research question, SRA researchers developed a detailed topical framework (Appendix B). A topical framework is a list of issues or topics that will be explored during the evaluation. For this study, it was phrased as a series of questions to be answered by observing and talking with visitors as they explored the *Bio Med Tech* exhibition and its included programming.

The rest of this report describes the methodology and methods used to answer the research question and discusses the findings and recommendations of the research study.

METHODOLOGY AND METHODS

In this study, *Methodology* refers to the overarching framework that guided the study, *Methods* refers to the data-collection strategies or techniques used during the study, and *Design of the Study* refers to the specific ways in which those methods were applied.

Methodology

This study used a naturalistic inquiry methodology, which is an ethnographic and primarily qualitative approach to understanding visitors and museums. Naturalistic inquiry is a rigorous approach to understanding experiences in the natural context in which they occur (Lincoln & Guba, 1985). The goal of naturalistic methodology is to provide a holistic understanding of an exhibition from a variety of perspectives. It usually includes collecting data from a variety of sources and triangulating that data to develop a thorough understanding of the subject of investigation. This approach to visitor research is particularly useful for complex projects such as *Bio Med Tech* because visitors will come to the project with varied experiences, interests, and levels of knowledge. Rather than looking for an average experience, naturalistic inquiry aims to describe the range of experiences and understandings. As such, naturalistic inquiry provides powerful tools for exhibit and program planners who are concerned with reaching complex audiences.

One of the strengths of naturalistic evaluation is that unanticipated findings often emerge from the data, often in visitors' own words. This type of inquiry allows the researcher to follow up on threads and themes that characterize how visitors think about their experiences. This approach also allows the exhibit team to develop a rich understanding of the ways in which users may react to, interpret, and learn from the *Bio Med Tech* project.

Data Collection Methods

A number of data collection strategies were developed to answer the research questions and guide investigation of issues listed on the topical framework (Appendix B). Each strategy is briefly described in this section.

SRA staff researchers visited the GLSC to collect data in the exhibition on three occasions during the winter and spring, 2008. On-site data collection used five primary methods: (a) *unobtrusive observations*, (b) *intercept interviews*, (c) *exit interviews*, (d) *participant observations*, and (e) a *written survey* that solicited responses from visitors who had attended *Bio Med Tech* theater presentations. At times when SRA researchers could not be present, this theater survey was administered by GLSC staff.

During unobtrusive observations, the researcher stood back and watched visitors as they explored the *Bio Med Tech* exhibition, trying to stay unobserved by the group being watched. Notes were made about which exhibits and activity carts the group stopped at, how long they stayed, and what they did and said at each exhibit and activity. As part of these observations, the

researcher sought to describe the range of Visitor Engagements displayed by that group, as described below. The data collection protocol for these observations is included in Appendix C: Sample Data Collection Protocols.

A depth interview is an open-ended and relatively unstructured conversation between a researcher and one or more respondents[3]. Depth interviews were conducted with respondents in two situations. First, after completing an unobtrusive observation at a particular exhibit or component, the researcher sometimes approached the respondent group to request an interview. This is referred to as an intercept interview. Second, the researcher sometimes observed visitor groups during their entire visit to *Bio Med Tech*, and then approached them as they prepared to leave the exhibition and asked if they would participate in an interview. This is referred to as an exit interview. Starting with the questions in the topical framework, the researchers developed a depth interview protocol for the two interviews that focused first on what respondents had done with the exhibits and then opened up to a broader range of topics. The interview protocol is included in Appendix C. The protocol represented the starting point for researcher's conversations with visitors. During each interview, the researcher asked probing questions and developed new lines of inquiry based on the responses received from that respondent group. With respondents' permission, visitor interviews were tape recorded and transcribed for further analysis.

In addition to the unobtrusive observations described above, researchers also conducted participant observations with some visitor groups. In these cases, with visitor permission, researchers joined an individual or group once they had begun interacting with an exhibit component and asked them what they are doing, thinking about, and experiencing. Participant observations often yielded information that was not possible with un-cued, unobtrusive observations described above. Because naturalistic inquiry by definition recognizes that the researchers influence what they are studying, researchers tried to note and understand the nature of their influences as they watched and talked with participant observation groups.

Because participants who had attended *Bio Med Tech* theater presentations tended to leave *en mass* at the end of the presentation, it was difficult to conduct depth interviews with more than one or two groups. To collect data from a broader range of program participants, the researchers and *Biomedical Technology* team collaboratively developed a brief written survey that was administered to audience members as they left the theater (Appendix D: Theater Program Survey). This survey included a mix of multiple-choice and free-response questions about how respondents had found out about the program, what new things they had found out about during the presentation, and what they appreciated most and least about the presentation.

[3] The researcher did not approach and interview groups of school children or other children unaccompanied by adults.

Design of the Study

Data Collection

Data was collected during three site visits to the Great Lakes Science Center during 2008: January 3-5, February 1-3, and April 4-5. Surveys were completed by participants in *Bio Med Tech* Theater presentations on February 2, March 1, and April 5, 2008.

Respondents

Respondents for the observations and interviews with *Bio Med Tech* visitors were casual visitors to the exhibition, including visitors who came singly, as part of small social groups (including families), or as part of school and scout groups. All respondents were purposively selected according to standards for naturalistic inquiry (Lincoln & Guba, 1985; Miles & Huberman, 1994) to ensure as broad a range of experiences as possible. The decision to observe a group was based on the evaluation's purposive sampling goals. For instance, sometimes researchers strove to maximize the diversity of such characteristics as age, gender, social configuration, ethnicity, and presence of a disability. In other cases, groups were selected because they had stopped at a particular exhibit of interest, or because they were engaged in a way that seemed likely to expand understanding of an issue of interest.

Because both SRA and GLSC were committed to the ethical treatment of respondents, throughout this study researchers adhered to standard professional practices for conducting naturalistic research in settings of informal learning and ensured that the disruption of visitors' experiences was kept to a minimum. During all periods of data collection, signs were posted informing visitors of the research, and during initial verbal contacts visitors were given a clear option to not participate in the study. Confidentiality was maintained by not asking for visitors' names and by removing from transcripts any identifying information that was inadvertently revealed during the interview. Children were interviewed only if their parents were present and gave permission.

In all, SRA staff spent about 50 visitor contact hours in the exhibition, which included time for observing and interviewing visitors and for debriefing about the resulting data. Including all methods of data collection, there were 483 individual respondents from 130 respondent groups. For a more detailed description of the respondents in this study, see Appendix E: Description of Respondents.

Analysis

Data analysis for this study was an on-going process using a modified inductive constant comparison approach (Lincoln & Guba, 1985). This method takes each unit of data and systematically compares it to all previous units of data. For instance, data analysis for the interviews took place at three junctures. The first was during the actual interview. During the interview, preliminary understandings were developed and tested out with respondents. The second juncture was after an interview, when the researcher sat down with a computer and typed up a formal debrief. The debrief summarized the data collection session, recorded the researcher's interpretation of the session, and compared it to previously collected data. At the same time, the researcher also developed questions to be explored in subsequent data collection sessions based on what was found to-date, including any special areas of interest. The third juncture took place during the planning and writing of the final report, as the researchers

revisited the debriefs, analyzed the transcripts, discussed the findings as a whole, developed preliminary conclusions, compared them with data collected from other parts of the study (e.g., the literature review), and wrote and revised the report.

Analysis of the written surveys by SRA staff included both calculation of basic statistics for the quantitative questions and both quantitative and qualitative analysis of the free response questions. Survey data were used to triangulate findings based on observations and depth interviews, becoming another facet of the constant comparison approach discussed above.

Because of the iterative nature of the analysis, readers will not find a one-to-one correspondence between a piece of data and a conclusion or recommendation. Rather, the findings discussed in this report result from synthesized data, gathered from a variety of sources.

In this report, quotations are included from interview transcripts to illustrate the themes and issues that emerged during the research. These quotations were selected as examples of the range of ways in which respondents talked about the topic in question. However, the number of quotations used in the report does not represent the relative frequency or strength of a particular response.

Visitor Engagements

As part of the data collection, four types of visitor engagements with the exhibition and activity carts were of particular interest: physical, intellectual, social, and emotional. These four types of engagements are not — and are not meant to be — mutually exclusive. They are described below.

Physical engagements were all the physical things visitors did at the exhibits or activities, such as standing, running, bending over, pushing a button, using a track ball, reading a label, looking closely at an object, watching a video, and so forth.

Intellectual engagements were all the ways in which visitors engaged cognitively and intellectually with the exhibits and activities, including ways visitors thought about, processed, and made meaning of their experiences. Although some types of cognitive interactions could be judged through observations and overheard conversations, most data about intellectual engagements came from the interviews and participant observations.

Social engagements were the ways in which visitors engaged with each other to make meaning of their exhibit and activity experiences, including verbal exchanges and body language. Researchers attended to the extent to which, and ways in which, visitors engaged socially with others in their groups, and in particular their teaching and learning interactions.

Emotional engagements were all the ways that visitors engaged emotionally with the exhibits. Researchers looked for indicators of relevant emotional engagements such as excitement, surprise, satisfaction, frustration, or confusion.

Engagement data was collected during the site visit and then analyzed in order to understand why some exhibits seemed to achieve their goals effectively and others did not.

Limitations

Due to limited resources, this study was necessarily limited in scope. When conducting an evaluation study using naturalistic methodologies, it is standard practice to continue collecting data until a state of redundancy is reached. Redundancy is the point at which no new information is gleaned, despite repeated attempts to elicit additional findings. In this study redundancy was achieved for many of the issues listed in the topical framework. However, some areas of interest could not be explored in enough depth to reach redundancy. Where appropriate, the report identifies issues that could not be resolved satisfactorily.

Finally, while this evaluation included studies of visitor engagement with the *Exploration Carts* and *Bio Med Tech* theater presentations, these programs were not a primary focus of the remedial/summative evaluation. Rather, researchers investigated the ways in which engaging with these programs contributed to visitors' understandings of the themes and concepts presented in the *Bio Med Tech* exhibition. This part of the study should not be considered to be an evaluation of the overall effectiveness of the programming in the exhibition.

FINDINGS

Following is a description of our major findings from this study.

Overall *Bio Med Tech* Experience

As researchers observed and talked with visitors to the *Bio Med Tech* exhibition, it was clear that many visitors in the target age ranges were engaged with the graphic/text panels, multimedia components, and interactives. For middle and high school students, the interactive exhibits proved particularly engaging, particularly the endoscope, MRI, and CT "spinner" in medical imaging, the "Share Your Thoughts" talk-back board, and the *Investigation Stations* with the prosthetic arm and DNA puzzle on the other side of the exhibition. Adult visitors were more likely than students to engage with the graphic/text panels. In exit interviews, adults often recalled details from the second and third paragraphs of label texts, particularly those that they found particularly relevant to their personal interests or medical histories.

For Many Visitors, This Was Personal

As stated earlier, the main message for this exhibition was,

> *Rapidly advancing biomedical technologies give doctors new tools to improve personal and public health*.

Of all the concepts embedded in that message, visitors connected most readily to the *personal* aspects of *Bio Med Tech*. Visitors found a range of personal connections with the many devices and procedures on display, and they often discussed those connections publicly with others within their groups. Many of these connections related to health issues faced by the visitors or their friends and relatives. For instance, the open MRI in Medical Imaging was a focus of much of this discussion. Like the following, some visitors' responses were based on their own experiences.

> *I've had an MRI on my knee. [They put me inside and] I hated that. I'd never do that again. So I was kind of intrigued by the open MRI.* (080203-01)

Others were intrigued because of their relatives' experiences with MRIs.

> *We went to the MRI and looked at some of the readings from that. That was very interesting because our Grandma has that done several times a year, and so we were able to see what that was.* (080201-05)

Still others were thinking of the day they might experience an MRI procedure of their own.

> *Now I'm looking at it thinking that I've never had an MRI. I've never seen an MRI, but everybody I know has had one. So I was kind of like, "Oh, what would it be like to lay there." It gave me an idea before I ever needed one.* (080404-10)

Visitors responded in similar ways to other exhibits in Medical Imaging, as well as to the prosthetic limbs on display.

> *I really like the [CT scan spinner] display showing the baby teeth, because that's where my daughter is at right now, facing extraction of teeth. And that was interesting to see the imaging on the ten year old's face. I mean that's just what we're facing right now, so I found that very interesting.* (080405-05)

> *I also had surgery on my intestine, so I kind of know some of that [endoscope] stuff.* (80104-07)

> *I liked the prosthetic leg part, because my mother, their grandmother, has a prosthetic below the knee. And she just got a new leg, and they just saw it, where her ankle bends for the first time in four years. So she had to relearn how to walk for the first time in four years with a bending ankle.* (080404-10)

As noted in some of these quotations, visitors often shared their experiences with their children and others in their group. For instance, at the Infectious Diseases section, some visitors talked about their own families' experiences with West Nile Virus, and at FES, visitors talked about people they knew who were in wheelchairs. Mothers, in particular, had experiences to share at the panel on advances in ultrasound technology, often sharing them with their children (who were not always impressed).

> *We were looking at the ultrasounds, because [my daughter] was born with a birth defect, which we knew about prior to her birth. So I was in about every other day having an ultrasound, monitoring her and showing her we could see her blood flow and they would check everything about her. And she just kind of goes, "Uh, cool!" [She] had no idea what that did for me every day, being able to see her and knowing that she was fine. I think this meant a little more to me than to them.* (080404-10)

Although most visitors connected to the exhibition from the patient's point of view, others felt connected through their professions. These included visitors with all types of health and engineering-related careers. For instance, medical doctors were observed using the exhibits to explain their work to children and parents, and a former nurse told her date about assisting surgeons with the abdominal clamp on display in the entrance case.

Younger visitors who showed deep interest in the *Bio Med Tech* exhibition often told us they were already interested in human biology and/or already considering health professions as a career. For instance, a seventh-grader on a school visit came up to a researcher after spending 20 minutes exploring the exhibition. She thanked him for the exhibition, saying, "This is really cool. Thanks for putting it all together and taking the time to do it." She said she wanted to be a "pediatric biomedical engineer" when she grew up, a term she apparently learned from her uncle, who she said made artificial hip bones. Teens who engaged for long periods with the DNA

puzzle activity were often already interested in the subject, like this high school AP biology student.

> *I'm a big science dork, I love science. [So are you thinking about careers in this?] I am, very much, that's why I wanted to check this one out.* (080104-05)

Researchers also talked with a father who had engaged in deep and wide-ranging discussions about the implications of DNA testing with his daughter. He described her as a high school junior and a "potential medical student."

In a way, the strength and depth of visitors' personal connections to biomedical technologies was not surprising. The front-end evaluation found similar connections between GLSC visitors and the predecessor *Medical Technology* exhibition.

> *Visitors to the* Medical Technology *exhibition displayed a range of personal connections to the objects and topics they encountered in this gallery. Some of the strongest connections were by visitors who had experienced—or thought they might someday experience—the medical procedures as a patient. We also talked with quite a few respondents who worked in health care, telling us (or their companions), "This is part of my job." A few children described themselves as future medical professionals, although more frequently we talked with parents who said they wanted their children to be doctors when they grew up*. (Gyllenhaal & Ziff, 2006, p. vi).

The new *Bio Med Tech* exhibition did elicit a new type of personal connection, not seen with the earlier exhibition. Some visitors who expressed strong personal connections with *Bio Med Tech* turned out to be current or former students and employees of Case Western Reserve University, which had partnered with GLSC on this project. One visitor spent almost a half hour exploring the exhibition, and then returned a half hour later to attend a *Bio Med Tech* theater presentation by a Case professor. She said about her family,

> *We have a Case background, I used to be an employee there, my niece and nephew were graduated, and my sister is there now. So it's very interesting to me to see all that.* (080405-05)

Another visitor became visibly excited about the exhibition's credit panel (Fig. A-3), pointing out names to his companion. It turned out he had graduated from Case and was pointing to names of some former professors, who had served as advisors to the exhibition team.

What Visitors Gained from Their Experiences

Given the range of personally interesting topics explored in *Bio Med Tech*, it was not surprising that most respondents in the summative study were able to describe something they had found out in the exhibition that was new and interesting to them. Most respondents said they found out specific information from the exhibitions. For some respondents, the exhibition made them aware of new areas of medical technology.

I never heard of FES before. (080203-01)

Other respondents reported filling in specific gaps in their knowledge of areas of science and technology with which they were already familiar.

[What did you find out about stem cells that you didn't know before?] The legality, currently. (80104-06)

I didn't realize the time frame [of stem cell extraction]. (080201-07)

And some respondents discovered surprising connections between technologies.

I saw one blurb about [how] the music industry was also developing the CT scan, so some of the funding that they received from promoting the Beatles was used to develop the CT scan. That was the only thing that caught my eye in that area. (080201-08)

Many respondents walked away with memories of the experience itself, which went beyond declarative knowledge of facts and concepts. In an exhibition that shows technologies and how they work, it's not surprising that some respondents found themselves able to visualize medical technologies in ways they had not been able to before.

I'm completely unable to understand all the technologies, but I want to stay current. I think this is a good way for older people the keep up on, for instance, the prosthetics. To see the development, from that glass case back there [with prosthetic legs]. There's still a part of me that feels overwhelmed by, how does everything work? I think there is no way to explain other than to just sort of see it and experience it. (080404-04)

[I liked] the mechanical arm. I like to see how it works. (080202-04)

Young children's learning was, not surprisingly, different form most adults' learning. Children sometimes learned more about the human body than about biomedical technologies, and that knowledge could be seen as a precursor to understandings related to the goals of the exhibition. Caregivers noticed what their children were learning, and some wondered if the GLSC might be able to offer more exhibits about the human body. Some mentioned the Cleveland Health Museum, which had closed and left what they perceived as a gap.

[This exhibition] reminds me a little bit of the old Health Museum that used to be here [in Cleveland]. But I would have liked to have seen some of the things that the old Health Museum used to do, which were more children's things. I'm trying to think of like the teeth, and they would have exhibitions about what happens when you drink and all that kind of thing. I think some of the things from the old Health Museum would be a lot of fun in there. (Grandmother with 7-year-old; 080404-06)

Although most visitors found out personally meaningful information in *Bio Med Tech*, that does not necessarily mean that the exhibition achieved its major goals. The next section discusses visitors' understandings about the exhibition and its messages in relation to the project's main message and four major goals of the exhibition.

Achieving *Bio Med Tech* Goals

Advances in Biomedical Technology

As stated previously, the main message or big idea for this project was:

> *Rapidly advancing biomedical technologies give doctors new tools to improve personal and public health.*

And the first goal of the exhibition was stated as follows.

> *Visitors will be amazed at the rapid advances that biomedical technology researchers are making in a wide range of fields.*

There were encouraging indications that most adults and many older teens recognized the major thrust of this "advances in biotechnology" theme, although the terminology they used to describe their understandings varied. When researchers asked respondents how they would describe the exhibition to folks back home, there was often a two- to four-second pause while they thought about the question. Respondents seemed to struggle to come up with a description that would fit an exhibition that included machines like the MRI and endoscope, medical conditions like infectious diseases and paralysis, treatments like prosthetics and FES, and bioscience topics like microscopic organisms, stem cells, and DNA. Almost all respondents included a term describing the progress and currency of the exhibits they had seen.

> *I would say it was about medical breakthroughs and the most recent updated medical findings.* (080201-08)

> *Progression of medical technology*. (080404-09)

> *The future of medicine and health and stuff like that. How they are making advances and breakthroughs in different things.* (080202-03

> *A lot of new research, that's like reported on in the newspaper*. (080203-07)

> *Well, it's about medical technology, isn't it? The things that are being worked on right now.* (080201-07)

It's clear that the concept of "rapid advances" was coming through to most visitors, but there was variation in respondents' perceptions of what was advancing.

> *Advances in the medical profession.* (080201-06)

It had a lot to do with the medical field…a lot of advancing medicine. (80104-07)

Advances in modern medical science. (080404-12)

About science, advances. (80104-06)

Advances in health care. (80104-06)

The term that inspired the title for the project and exhibition, "biomedical technology," was used rarely by respondents. Biomedical technology is a field big enough to include everything from MRIs to DNA, but it was not a term that rolled off the tongues of GLSC visitors. However, most respondents included some aspect of the biomedical technology field in their description of the exhibition. They talked about *science* and *research* (the "bio" part), *medicine,* or *technology* – and sometimes two of the above – but rarely all the aspects of the exhibition.

In retrospect, this should not be surprising. The front-end evaluation revealed that few GLSC visitors were familiar with the term "biomedical technology."

> *When we asked visitors what the term "biomedical technology" meant to them, adult respondents often made fairly accurate guesses, even though many of them were unfamiliar with the term "biomedical." The term "medical" had clear meanings to adults, and made them think about "cures" that used technology in some ways.* (Gyllenhaal & Ziff, 2006, p. 9)

Respondents to the front-end study often had trouble recognizing the scope of the biomedical technology field, in part because of their limited definitions of the term, "technology." When asked what topics they would expect to see in an exhibition about "biomedical technology,"

> *Certain topics were common[ly mentioned] because they included both "cures" (i.e., the medical part) and something that fit their preconceptions about technology (which tended to involve machines or computers)…. Infectious diseases were regarded as BMT [biomedical technology] topics when they were "new" diseases for which doctors were actively looking for cures; for example, our respondents tended to see avian flu and bio-terrorism as BMT topics, but not malaria. Our respondents were divided as to whether gene therapy should be included as BMT.* (Gyllenhaal & Ziff, 2006, p. 9)

So, not surprisingly, when respondents in the summative evaluation were asked about the term, "biomedical technology," most said they were certain of its meaning. The few respondents who provided accurate and complete definitions of the term turned out to be medical professionals or, in one case, a student of biomedical technology at Case Western Reserve. Others who said they recognized the term had trouble defining exactly what it meant.

> *Actually, I have a friend who studies biomedical technology at Case….[Why do you think they put the bio- in biomedical?] I don't really know. That's a hard question!* (080404-12)

The *Bio Med Tech* exhibition introduced the term "biomedical technology" (and in some cases "biomedical engineering") in some entrance exhibits, but even those exhibits did not focus on the meaning of the term. The term was rarely used in the other sections of the exhibition, where visitors spent most of their time. Given where visitors started from, it's not surprising that they did not gain a greater understanding of the meaning and scope of biomedical technology.

The preceding discussion focused on adults. Although many older teens also recognized that the exhibition focused on advances in medical technology, younger children (and sometimes their parents) focused more on what they had seen and done and less on the larger ideas related to the exhibition. Some children focused on the technologies that could see inside the body.

> *[The exhibition] talks about X-rays, looking inside, all sorts of stuff.* (10-year-old child)
> *It was interesting to actually see some of the things that doctors are able to see, and see the equipment and the results.* (Child's mother; 080201-05)

Other children focused on what the technology saw: The human body and what can go wrong with it.

> *[The exhibition] is about your body. Like it tells you what happens if you have a disease or something, and anything happens.* (10-year-old; 080404-10)

One parent had an interesting theory about why children tended to focus on technology as it is, rather than on advances that had taken place. She developed her theory because her 8-, 10-, and 12-year-old children had seemed unimpressed when she pointed out examples in the exhibition.

> *I don't know if they understand technological advances, because they happen so quickly in their lives.* (080404-10)

There is additional discussion of how families with young children experienced *Bio Med Tech* later in this report.

Who Creates Biomedical Technology, and Where They Do It

Two additional goals of the exhibition were:

> *Visitors will gain perspective on the broad range of professions that contribute to advances in biomedical technology.*
>
> *[Cleveland-area] visitors will feel proud that so many new biomedical technologies are being developed right here in Cleveland, at places like Case Western Reserve University.*

During the summative study, there were indications that most visitors were learning little about either goal. In fact, respondents who had completed their visit to *Bio Med Tech* often said they had not noticed that these topics were discussed in the exhibition.

For instance, most summative evaluation respondents did not remember finding out about the many professions that contributed to the development of new biomedical technologies. The

exceptions to this observation were respondents who worked or studied in the medical field. These visitors often commented about the way their professions, or in some cases their professors, were depicted in the exhibits. They seemed much more likely than most visitors to notice and remember the exhibits that mentioned this topic, which included a video and graphics panel in the FES section (Fig. A-16, on the right) and a label on the *Teams and Tools* panel about infectious diseases (Fig. A-9). Of these two panels, the FES panel seemed to attract the most visitor attention.

> *I'm a physical therapist, so [*Bio Med Tech*] is probably my favorite room. I'm especially interested as a therapist in the FES exhibit, because it talked about how the therapist used that functionally*. (080201-08)

> *One of the guys in there is one of my professors, Hunter Peckham. So, I just wanted to see what they had about the FES. So I though that was pretty cool…[I'm a major in] Biomedical Engineering.* (080404-11)

Perhaps it was not surprising that professionals and students in the medical fields would be interested in any mention of their professions. During the front-end evaluation, there were indications that this subject was less interesting to most other visitors. For instance, when front-end researchers discussed the people and places involved in the development of new biomedical technologies with visitors, respondents were less interested in this than in other topics being considered for the exhibition. Front-end respondents also seemed to have incomplete ideas about how new medical technologies were developed.

> *Most thought medical doctors took the lead by seeing a need and finding a way to fill it. Some respondents seemed to think that doctors worked alone, except perhaps when they "got stuck" and needed help from an electronics expert, engineer, or scientist.* (Gyllenhaal & Ziff, 2006, p. 10)

Again, the issue seemed to be the lack of emphasis on this topic within the exhibition. It seems that the relatively few mentions of this topic in the completed *Bio Med Tech* exhibition – and the relatively static approach to exhibiting this topic – were not enough to attract and maintain visitors' interest.

When respondents in the front-end evaluation study talked about *where* biomedical technologies were developed, visitors from the Cleveland area did seem more interested in this topic than in the more general topic of biomedical technology professions.

> *It was clear that local visitors were interested in the "Cleveland connection" in all its forms. Several local visitors expressed pride at the Cleveland connection, and some visitors from other locations expressed pride in [biomedical technology] organizations that were located in their home towns.* (Gyllenhaal & Ziff, 2006, p. 11)

However, in the completed *Bio Med Tech* exhibition, there were relatively few mentions of biomedical technology's Cleveland connections other than the entry exhibits (e.g., Figs. A-4 and

A-5) and the FES section (Fig. A-16, Cleveland FES Center mentioned on three label panels, second paragraph or later). Surprisingly, the entry exhibits did not attract as much visitor attention as might be expected based on their location. For instance, the large Cleveland Connections panel was located in the central island inside the main entrance, in what might seem to be a featured position. However, most groups observed by the researchers turned right or left as they entered the exhibition, often gravitating first to the interactives visible from the entrance. Visitors often left the exhibition without even noticing the Cleveland Connections panel.

When they noticed the connections to Cleveland, respondents often expressed interest in them, such as this visitor interviewed after he had walked out of the exhibition.

> *Cleveland connections is a good idea. I didn't notice [the Cleveland Connections panel] until just now. Why not have a whole exhibition related to Cleveland connections and science? That's the future of our town.* (080404-04)

Researchers noted that there were several missed opportunities to link popular exhibits to Cleveland. For instance, several labels mentioned Philips as the developer and donor of the open MRI, but none pointed out that this company has a Cleveland connection.

Controversies in Biomedical Technology

The last of the four main goals of the exhibition was stated as follows.

> *Visitors will appreciate that GLSC respects their opinions about controversial topics related to biomedical technology.*

Visitors' perceptions about controversial topics in *Bio Med Tech* centered on two sections of the exhibition, the "Share Your Thoughts" bulletin board and Stem Cells, and those are discussed in this section of the report.

The "Share Your Thoughts" bulletin board used a provocative question to solicit visitors' opinions about issues related to biomedical technology. To investigate visitors' engagements with this exhibit, researchers both observed visitors as they read and responded to the exhibit's question and other visitors' posted answers, and interviewed them after they had left this section of the exhibition.

Many respondents expressed surprise at the range of responses that were posted on the board. In particular, respondents with an interest and background in science were often surprised at the religious influences evident in many of the responses.

> *I didn't realize how many people are really religious with their views. I feel like a lot of people were like, "Don't mess with God!"….I don't know. I didn't realize. I guess I'm not a super religious person, either. I'm more fact-based.* (Biomedical engineering student; 080404-11)

However, respondents also expressed tolerance for the range of views.

It's good to be open to different viewpoints, and to see how different people react to different things. (080404-11)

[Did any of the comments seem like they didn't belong in a science center?] No, if people decide that they don't want to be tampered with, that's a perfectly viable choice. Either or. (Physics student 080404-12)

There were indications that children completed most of the postings on the bulletin board, and their postings included a range of relatively superficial and very well-thought out responses. Many adult respondents said they were impressed by the number of children who had posted responses to the question, and some had trouble believing that children could be so thoughtful.

I thought some of them were kids, some of them I thought were adults posing as kids. The thoughts are pretty thorough and well drawn out. Usually kids don't automatically start thinking, "Oh, you know…" They usually think, "Oh, I wish I didn't have this," at a very fundamental level. But then again, some kids, I could be wrong. (080404-12)

Other respondents expressed concern that an exhibit as open as this might be subject to abuse.

As long as people don't get silly with it, I'm all for it.…It's nice to read what people have to say, as long as they don't get silly about it. [And] as long as it's not something that's vulgar, I want to say. As long as somebody doesn't slip a vulgar note in there, and they keep with the scientific aspect of it, I find it interesting. (080405-05)

But, as noted above, there were indications that most visitors enjoyed the way that this exhibit exposed them to a range of points of view of topics related to the exhibition and gave them an opportunity to express their own views. However, there were indications that the bulletin board was foremost a test of visitors' respect for other visitors' opinions. Respondents did not seem to perceive this exhibit as evidence that GLSC respected their opinions about controversial topics related to biomedical technology. In other words, providing a forum was not necessarily perceived as a sign of respect to all those who participate.

The Stem Cells exhibit panels presented information about stem cells, but did not provide a place for visitors to respond to the content displayed in the exhibit. Therefore, researchers talked with visitors about the perceived fairness of this section of the exhibition. Many respondents said they recognized that stem cell extraction and use was a controversial topic; however, there were indications that most respondents considered the *Bio Med Tech* presentation about stem cells to be informative, balanced, and providing a viewpoint that helped them put the controversy in perspective.

I think [the stem cell exhibit] goes both ways. I think it's good that it helps to inform your opinion. Because I think it's difficult to understand what stem cell research is even about, so it was kind of cool to see that. (Respondent 1; 80104-07)

Respondents liked both the information in the stem cell section and the way it was presented.

> *The stem cell description was better, was succinct and I think a real good current overview. It was just well organized, the material was well organized.* (080201-07)

Even visitors who considered themselves well informed about health science sometimes said they learned something new in this section.

> *We're doing a lot of reading about a lot of things. We're kind of into the health sciences. So, I don't know if [there was] anything new. Maybe in the stem cells…I didn't realize the time frame [for stem cell development]*. (080201-07)

Only a few respondents thought the balance tipped a bit to the positive side about stem cell therapies.

> *[Stem cells] showed both sides, just it was [more] informative about the benefits of it.* (Respondent 2; 80104-07)

Despite the range of opinions that respondents expressed about stem cell research, none seemed to feel that their views on the topic were not respected. This exhibit in particular helped achieve the fourth goal of the *Bio Med Tech* exhibition.

Effectiveness for Different Sorts of Visitor Groups

Overall, effectiveness of the *Bio Med Tech* exhibition appeared to vary depending on three interrelated factors:

- **learning style preferences** of group members,
- type and degree of **interest** and **personal connections** that respondents felt to the topics covered in the exhibition, and
- **interpretive and meditative skills** of the visit facilitators (who were often parents or peer-group leaders).

Learning style preferences mattered because much of the exhibition consisted of graphic panels and video segments, which were most effective with visitors who enjoy learning from text, images, and/or spoken word. Individuals who prefer learning from three-dimensional objects or interactive exhibits enjoyed some parts of the exhibition (e.g., prosthetics and some aspects of medical imaging), but were less engaged with the rest of the exhibition.

Personal connections mattered because that was the hook that drew many visitors into the exhibition. As mentioned in an earlier section, many personal connections fell into one of two categories: Health issues faced by visitors and their friends and relatives (i.e., the patients' point of view), and professional or pre-professional interests. Because health issues were often specific to a particular topic or technology, respondents' engagement also varied as they explored *Bio Med Tech*.

When groups with children and all-adult groups explored *Bio Med Tech*, their visits were often facilitated by parents and grandparents (for the children in their group) or by group members who had specialized interest of knowledge in the topic or technology on display. This second category included medical professionals visiting with their families or friends and visitors with a particular medical condition, who often had personal experiences to share with the companions. Thus, teens with an interest in human biology and adult children who worked in health fields sometimes found themselves facilitating their parents' understanding of *Bio Med Tech* exhibits.

These three factors help explain why many – but not all – families with young children or teens left *Bio Med Tech* after a short visit, with unengaged children and frustrated adults. Relatively few exhibits supported the active learning styles preferred by many children and teens, and adults' attempts to interest their children in the graphic panels were usually unsuccessful. Because their children were not interested, these caregivers often left the exhibition before they had a chance to satisfy their own interests in the topics included in the exhibits.

These factors also explain why large groups with middle and high school students tended to split up when they encountered *Bio Med Tech*. Most of these students would take turns trying out and discussing the interactive components, and then leave after a few minutes without paying much attention to the graphic panels. However, smaller groups of middle and high students would stay behind for up to a half hour, exploring many types of exhibits in greater depth, including graphics panels. Those who lingered almost always expressed a strong existing interest in human biology, engineering, and/or health care professions.

Some adult visitors said the *Bio Med Tech* exhibition was one of their favorite parts of Great Lakes Science Center. These visitors tended to like reading the labels, preferring them to more interactive elements.

> *The thing about this exhibit, I like it, it has a lot of information…. It isn't a video game room, so it's more educational.* (080201-08)

These visitors compared *Bio Med Tech* favorably with other parts of the Science Center.

> *There is a lot more information here than in…the physics exhibit…[In the physics exhibit] there was a lot of things where you could press buttons and do, but then the information with it was kind of scarce and less organized. So I felt like* [Bio Med Tech] *is very organized and there's a lot more information here than in the exhibit I was just saying.* (080201-08)

Finally, these factors also seem to explain why *Bio Med Tech* seemed to be particularly effective for couples. Although we talked with many singleton visitors who enjoyed and learned from *Bio Med Tech*, the exhibition seemed to work best when shared with another visitor. Researchers watched many couples walk through the exhibition together, sitting side by side at the interactive components, and sharing their interests, experiences, and individual expertise in health science or technology. Sometimes, one member of a couple would facilitate the experience for the other; often, they seemed to share the experience equally. These couples varied from high school and

college aged visitors on dates, to young married couples with infants in strollers or snugglies, to middle-age married couples with older children elsewhere in the museum (or elsewhere in the world), to widowed or divorced adults who were, like their younger counterparts, also on dates. In fact, *Bio Med Tech* seemed like something of a "date magnet" for couples in GLSC. For couples, the interactive exhibits were most engaging when there were two stools waiting, side by side, as they approached. Couples often sat side-by-side before they really knew what they were going to be doing at the exhibit, worked together to figure it out, and then talked about how it related to their lives. Although the graphics panels did not always interest both members of a couple equally, the less interested one would usually defer to the other's interest, rather than dragging them away like a bored or distracted child.

As noted above, the *Bio Med Tech* exhibition was a more difficult experience for many families with children, especially those ages eight and younger. Caregivers with younger children often found it difficult to keep them engaged with many aspects of the exhibition. In exit interviews, these caregivers often stated that (1) the exhibition seemed to have relatively few hands-on or interactive exhibits that held their children's interest, and that (2) they found it difficult to explain some of the exhibits to their children and to answer their questions about these topics (particularly DNA and Stem Cells).

> *It was a little over their heads. They're 8 and 10. [It's] more for older children.* (Parent with elementary age children; 080201-05)

> *I think it's probably more interesting to older people than to younger children….I think a child would have liked to have seen more of the [real] skeleton. Something like more hands-on things, maybe. I think the stem cells is a little beyond their comprehension. I found it interesting, though.* (Grandmother with 7-year-old; 080404-06)

Families had a more satisfactory experience when they spent most of their time in the exhibits about medical imaging and FES/prosthetics. These exhibits portrayed macroscopic, concrete objects, like the endoscope, MRI, and prosthetics, and images with identifiable organs, often using interactive exhibit approaches. With preschoolers, successful caregivers often used these exhibits to talk about what's inside the body and how the body works.

> *We looked at the MRI machine, and we looked at the inside of the knee. That was kind of neat for my little kids. We looked at the inside of the stomach. But that's all we looked at, because it wasn't appropriate for four-year-olds.* (080202-02)

With older children, caregivers also talked about how technology lets doctors see inside the human body, what can go wrong with the body, and what doctors can do about it. Caregivers found it easier to engage children with these last two issues when children knew a family member or friend with a medical condition depicted in the exhibit.

Finally, we should point out that the issue of preferred learning styles applied to adults as well as children. As noted above, many adults enjoyed the graphics panels and multimedia elements;

however, others expressed a preference for more concrete, hands-on, and interactive experiences. For instance, here is what two visitors in their 20s had to say.

> *Some things were not as interactive as others, I guess.* (Visitor 1)
> *The more interactive, the better.* (Adult visitor 2)
> *We enjoyed the more interactive the best. That's why we probably enjoyed the DNA [cart activity] the best, it was literally hands on.* (Adult visitor 1) (080201-06)

For some adult visitors, interactivity and visuals were the key to their enjoyment and learning.

> *I don't read labels. I look for the interactive or the visual. So I'm not a label reader… I look at that [Stem Cell] wall, and I see print, all print. Which immediately moved me away with it….Words, too many words, not enough movement, this wall. This [medical imaging] wall had great movement.* (Retired elementary school teacher; 080404-04)

For others, it was also about seeing and interacting with real things.

> *There's not a lot to do [in* Bio Med Tech*]…. It kind of looks like a state fair, where you walk around and there's little things that just tells a little about something and that's it….Maybe [there should be] more displays like the endoscopy where it's showing you the film but you're seeing how it actually works by seeing the body part…. [The exhibition needs] more things, more interactive things, maybe more 3-D things that aren't computer-generated only…Like go to the Cleveland Museum of Natural History, things like that.* (080202-06)

Because many groups that come to GLSC include young children, active teens, and adults who prefer interactive learning, it was not surprising that *Bio Med Tech* was often sparsely populated compared to some other areas of the building. For instance, on the first floor, the other technology galleries, with their numerous interactive exhibits, seemed to attract and hold more visitors, and the interactive galleries on the second floor were almost always more crowded with visitors. These exhibitions attracted younger visitors and then held them for a long time; *Bio Med Tech* attracted younger visitors, too, but was not as effective at holding their attention for long periods of time. Because couples and other adult groups stayed longer than many other groups, there was often a higher ratio of couples/adults to family/school groups here than elsewhere in the Science Center.

Effectiveness of Individual Exhibit Components

Individual exhibit units varied in their success at achieving their stated goals and communicating their intended messages. As can be seen by reading through the following subsections of the report, the Medical Imaging, Prosthetics, and FES exhibits were relatively successful for all ages of visitors, and the Stem Cell exhibits were effective for most adults and many older teens. However, the Genomics and Infectious Disease sections seemed less effective for most visitors.

Several factors seemed to contribute to exhibit effectiveness. The goals of exhibit sections were more often achieved when the goals were concrete and only a step or two beyond what most visitors already knew. Exhibits were also more effective when goal-related messages were communicated through a range of media, including hands-on and interactive exhibits, concrete examples of biomedical technologies, and visitor-controlled multimedia. Exhibits that were mostly text and graphics worked for some interested adults, but were less successful for younger members of the target audience (middle and high school students).

The rest of this section discusses findings related to each exhibit section, both to illustrate the generalizations made in the preceding two paragraphs and to facilitate the development of recommendations for remediation and lessons learned for future exhibitions at GLSC. Readers may want to review the description of the *Bio Med Tech* Exhibition as they read specific findings about the exhibits. The photos referred to in the text are in Appendix A.

Entrance Area

All visitors to *Bio Med Tech* walked past the entrance panels (Figs. A-1 and A-2), and researchers overheard a few visitors reading or talking about the texts on the panels as they entered the exhibition. Observations at the center section (Fig. A-4) suggested that most visitors turned right or left as they entered the exhibition. If they stopped to read the *Cleveland Connections* exhibit (Fig. A-5), they most often did so after they had visited the rest of the exhibition. Visitors seemed most likely to notice the credit panel (Fig. A-3) as they left the exhibition. The visitors who were observed stopping and reading this panel tended to be graduates of Case Western Reserve, and they sometimes said they recognized one or more of their professors on the list of advisors.

For those visitors who stopped to engage with these exhibits, the exhibits were relatively successful. For instance, most respondents who had looked at the *Cleveland Connections* exhibits said that the exhibition included examples of medical technologies developed in the Cleveland area. However, it should also be noted that even those visitors who had engaged with entrance area exhibits did not really show a detailed understanding that biomedical technology was the central topic of this exhibition (as discussed in the section on Achieving *Bio Med Tech* Goals).

Medical Imaging

Slightly more than half of the visitor groups observed in this study first stopped at the medical imaging exhibits (Fig. A-6). Most groups that entered this section stopped at both the endoscope and MRI exhibits, plus one or more of the exhibits on the west wall of the exhibition. For instance, the "spinner" controlled CT scan images (Fig. A-7) also received quite a bit of attention from visitors, as did the images on the "Advances in Ultrasound" panel (Fig. A-8).

The exhibits in this section, in particular the endoscope and MRI, were favorites for many visitors.

> *I liked when the camera went into the stomach. Like, you could make it go back and forth and see it's like in the stomach. And I thought that was really cool.* (080404-10)

The data indicated that for the most part, the exhibits in this section effectively achieved their goals and communicated their messages to adult respondents and older teens. This success seemed to be due to the balance of exhibit media included in the section, including real examples of technologies, interactive and multimedia components, and effective graphics and text. Younger teens and children also learned quite a bit from these exhibits, although they more often focused on more concrete aspects of the experience, rather than recognizing the advances over past technologies. Younger people were more likely to consider this section as being about *what* it looks like inside the body (for the youngest children) or *how* doctors see inside the body (for older children and younger teens).

Some children were rather put off by their medical imaging experiences, such as the endoscope, or by the whole idea of looking inside human bodies.

> *We were a little squeamish on some of the things.* (Mother)
> *Just one thing for sure. I do not want a little camera in my intestines! I'd much rather have an X-ray, not a camera.* (10-year-old; 080201-05)

> *The one little girl is more squeamish. That's why she left.…They're just more squeamish, I'm more technical, the little girls are not.…Mommy wanted to come in here more.* (080405-05)

Of course, for some children, disgusting was good – it motivated them to pay more attention.

> *It was the kind of disgusting that makes you want to see more*. (11-year-old; 080202-04)

Visitors' suggestions for improving this section included letting them experience what it would be like inside the MRI.

> *I would like to experience going in the MRI. I'd like it to be more interactive. Really, if you can go in and have someone do that, just so you have a sense of what it is. That intrigues me.* (080404-04)

> *I want to be able to do an MRI of me!* (080404-11)

> *I thought it would be cool to experience what it would be like to be inside the MRI, like have a place where you lay down in it or something*. (80104-07)

The "spinner" was puzzling to some visitors. Some wanted the experience to include sound as well as images.

> *It seemed like it should have had sound. It was interesting to read and look at the images, but with sound it would have been better. Maybe if they could have read or told what was going on with those pictures.* (080202-02)

Others wanted more explanation about what they were seeing on the "spinner."

> *I didn't know what to look for. I was kind of puzzled by all three scenarios….It was still fascinating.* (080201-08)

The "spinner" was essentially a linear experience, where visitors could control the speed but not the sequence of images. Noting that, some respondents wished they had more control of the order in which they saw the images, and more choices about what they could see.

> *Maybe for that one thing with the spinner, maybe make a little more do whatever you want. Like you can chose from a selection of things and look at them yourself without having this tour.* (080105-09)

Finally, visitors at the endoscope often wondered what exactly they were looking at. Was it real? Was it human? The issue was also noted during the front-end evaluation (Gyllenhaal & Ziff, 2006, Appendix G); however, that report's recommendation to label the preserved pig stomach and intestine has not yet been implemented.

Infectious Diseases

Most visitors who had entered *Bio Med Tech* through the medical imaging section were observed stopping at least briefly in the infectious diseases section (Fig. A-9). Many visitors also looked at least briefly at the *Investigation Station* (Fig. A-10), and some successfully completed the activity. However, this exhibit was relatively unsuccessful at achieving its goal of helping visitors appreciate the many ways that biomedical technology is contributing to the diagnosis and treatment of emerging infectious diseases. In part, that was because the relatively static presentation did not engage visitors with the messages about the applications of advances in high-speed computing to improve treatment of infectious disease and about how advanced imaging devices help researchers identify infectious diseases. For instance, there were a few examples of the products of these technologies mentioned in the text, but no actual experiences interacting with the technologies (comparable to, for instance, the Medical Imaging exhibits).

Also, the mysteries that visitors solved using the *Investigation Station* card activities did not explicitly mention the technologies that doctors used to develop the clues (as had been recommended during the formative evaluation, Gyllenhaal & Ziff, 2007c). Thus, visitors were solving medical mysteries without realizing the importance of biomedical technologies in completing their tasks.

Finally, although many visitors were fascinated by the images of microorganisms displayed in this section, they were often frustrated by lack of interpretation with these images.

> *I was just wondering what those viruses were, what each was.* (080203-07)

> *Over there, when I was looking at the Tiny Terrors, and they asked the questions, one, two, three, and they wanted to know which was which virus? I went to pick up one of the cards, but I didn't want to pick up the card. I wanted to press a button to tell me, or to see them moving, or actually see those diseases outside of a photograph. But I want to see*

them moving, like there was a microscope, where you could actually see those cells. And then I would go to a card. (080404-04)

Because there were no illustrations or examples of the technologies used to produce these images, this part of the exhibit was more about microbiology than about advances in biomedical technology.

Theater

Most respondents said they had paid attention at least briefly to the videos projected continuously in the *Bio Med Tech* theater (Fig. A-11). However, relatively few respondents actually sat on a bench and watched an entire video program. The presentation of biomedical technology images projected during the first two site visits fascinated many visitors.

You see that movie, and that drew me right away. As soon as I walked in here, that movie was the first thing I wanted to go to. (080404-04)

However, this video also left many visitors a bit confused and frustrated. Many respondents said they wanted to know what the images were about, and how they related to the rest of the exhibition. Respondents often assumed that, since it looked like a video, the sequence of images should have sound – and they felt that the audio would help them understand the images.

We thought maybe the slide show should have some sound. It should either have something to read or a tape, something that tells you something. Headphones or something. (080105-09)

It seems like that screen should have sound -- the movie. Maybe it does have sound, but it's not on now. It looks really interesting, and my kids stopped and looked at it, but they didn't hear anything about it. (080202-02)

I thought it was good. I didn't really understand what it was portraying, to be honest with you. If there was any audio, I couldn't hear it. I didn't really understand what it was projecting. Looking at it right now, it seems to be encompassing all the parts of the exhibit. I saw the MRI and the prosthetic limb, so I could kind of deduce that. Other than that, I didn't understand when I first came in what it was for. I thought it was cool, it was nice, sort of makes the exhibit a little more eye catching. (80104-07)

Some respondents also assumed that, because they heard no audio, the exhibit must be broken.

The only thing I didn't like, I was trying to figure out that big exhibit right there [the big screen], but there was no sound, so I didn't know what it was doing. I didn't know what the screen was saying, so that exhibit is not functioning. (080201-08)

Note that respondents said similar things about the "spinner" in biomedical technology. Perhaps if it looks like a video, some visitors assume it will include sound.

The second video loop in the *Bio Med Tech* theater included both music and on-screen text that explained the images. Researchers heard few complaints about this presentation.

Bulletin Boards

The paired bulletin boards (Fig. A-12) received attention from most visitors we observed, although far more respondents stopped to read the postings on "Share Your Thoughts" than to read the single article posted on "Recent Breakthroughs." Although a relatively small percentage of visitors responded to the exhibit's question by filling out a sticky note, on a busy day the board was soon filled with responses, which sometimes overflowed to the adjacent board (Fig. A-13).

The "Share Your Thoughts" bulletin board is discussed in more depth in the report section, Controversies in Biomedical Technology. The Recommendations section includes suggestions for how the "Recent Breakthroughs" bulletin board might be used to more effectively achieve the project's goals.

Prosthetics

Most respondent groups that passed *Advances in Prosthetics* stopped at least briefly, with the prosthetic limbs and *Investigation Station* receiving most of their attention (Fig. A-14). The combination of real objects, interactive limb, text, and graphics helped this section achieve its goals with most adults and older teens. However, the detailed message of "how biomedical technology researchers are developing more sophisticated prosthetics and implants that include microprocessors, advanced biomaterials and/or living cells to enhance their function" was not communicated by the version of this exhibit that was evaluated. Also, for children, the prosthetics exhibits seemed to be more about *what can go wrong* with the body and *what doctors can do about it*. Even when their adults tried to help them focus on the advances in prosthetic technologies, this topic seemed to be something that young children have not thought much about, or have been curious about.

During the summative evaluation, the prototype version of the interactive prosthetic limb was essentially unlabelled, which led to visitor confusion and at least some frustration. Some visitors, for instance, referred to it as the "robotic arm," and they assumed it should be able to do things that it was unable to do.

> *There were a couple things, like the little robotic arm that's back there to pick up the pencil. Either they put it in a place where you couldn't because they didn't want you to reach it, or it had been bumped, but it was kind of frustrating to work that little arm and you could never get the pencil.* (080201-08)

These problems could be resolved with a well-written label.

Functional Electrical Stimulation

The *FES* section (Fig. A-15) also received attention from most respondent groups. Adults and older teens attended to both the multimedia and text panels (Fig. A-16), but younger children were more likely to select and watch the videos in the island part of this section (Fig. A-17). This exhibit was effective at achieving its first two goals with most adults and older children:

- *understand what FES is and what it can accomplish for patients who have lost the use of their muscles.*
- *experience empathy for the patients and appreciation for the ingenuity and industriousness of FES researchers.*

These understandings were communicated even to children somewhat below the target age range, as illustrated by the following quotes:

> *I liked how it showed the picture of the guy who was paralyzed, and he finally got on his feet. I thought it was pretty amazing how he could do that.* (10-year-old; 080404-10)

> *I liked when you had to press the button to see what the person had. It was grasping, and the woman was really happy that she would be able to hold her grandchild. And then for breathing, it would be cool that he could take his wife out to dinner, and he could actually eat instead of having to have a tube.* (12-year-old; 080404-10)

The third goal of this area--"developing FES technologies requires a team of specialists"--was achieved with only a few visitors, primarily professionals in the health care field. The message about defining FES was more effectively communicated than the message about how biomedical technology researchers work to make FES better. That was probably because the team approach and process of research were not emphasized in the exhibits.

Stem Cells

The *Stem Cells* section also received attention from most respondent groups observed in this study. Children of all ages were drawn to the small magnifiers on the "Where are my stem cells?" panel (center of Fig. A-19), and older children and teens often selected a video from the multimedia island panels (Fig. A-20). Adults and older teens often read one or more of the text panels, and many commented on these during exit interviews. Many adult respondents said they were interested in this topic, and researchers heard many compliments about how the information in this exhibit was explained.

> *The stem cell description was better; [it] was succinct and I think a real good current overview. It was just well organized, the material was well organized.* (080201-07)

In part because of adults' interest in the topic (and despite the rather minimal use of interactives), this exhibit seemed very effective at achieving its goals with adults and older teens. Because many caregivers attempted to explain the basic idea of stem cells to their children, it was also somewhat effective at helping older children understand the basic concept of stem cells. Although the five educational messages listed for this exhibit seemed rather ambitious, many adult respondents walked away with at least a partial understanding of four or more of them.

Genomics

In the *Genomics* section (Fig. A-21), most respondents engaged first with the DNA matching activity (Figs. A-22 and A-23), which was a third prototype *Investigation Station.* Some adults and older teens also read text panels, especially the ones associated with the activity and the text

on the wall to the right of the activity, which seemed accessible and memorable. (Some respondents even quoted from these labels as they discussed the exhibits.)

Many, but not all, visitors figured out how to assemble the DNA "puzzle."

> *It took awhile to figure out that you were trying to match strings of genes together and compare them to a known error or abnormal gene, and that it's just so you can see if they have that disease. I was thinking the puzzle aspect of the pieces.... It's actually more….I did get it, after a little while. I did get it.* (080203-04)

Relatively few respondents connected the matching activity to specific technologies used in DNA testing, in part because few read the detailed information about the SNP Microarray (Fig. A-23). Most visitors seemed to focus on the basic science of DNA and on the *idea* of DNA testing, without much thought about the technology used to conduct the tests.

Although genomics is defined as the study of the entire DNA sequence or genome, the exhibits in this section seemed most successful at focusing visitors' attention on the structure and functioning of short segments of DNA, and about the testing of humans for specific genes. That was because the most engaging aspect of the exhibition was the *DNA Investigation Station*, and few respondents developed a complete understanding of the complex technology this interactive was trying to represent. Most visitors did not figure out the connection between the activity and the microarray displayed on the panel above the activity. Here's what one visitor said about the microarray:

> *I thought it was broken. It's not broken?...It looked to me like it was broken. There's pieces missing from it.* (080203-04)

When visitors came to the exhibit with a more extensive understanding of genetics, they were able to understand more of the implications of the exhibits.

> *[It shows] how it would be affecting your life, and how gene testing can be a major part of whether or not you choose [to have children]*. (080203-04)

However, most visitors did not get that far, in part because they had to make connections between quite a few concepts that most were not able to sort through on their own. These concepts seemed to include:

- How you find a DNA match, and what that means when you do it – as related to splitting and recombining DNA molecules.
- The genetics of diabetes and its many meanings.
- What a microarray is and how it works.
- Variety of genetic analysis techniques used for different purposes (with microarrays as a breakthrough technology).

Although the exhibit goals included helping visitors understand what genomics is and increasing their comfort with some basic terminology and concepts of genomics, few visitors got that far.

Additional goals included impressing visitors with the many ways that genes affect human health, which was achieved with some visitors, and amazing visitors with recent discoveries in genomics, which was rarely achieved by the complex text panels included with this exhibit.

Health Careers Quest Computers
Many children sat at these computer stations and began exploring; few stayed for long. Even teens who were considering careers in science or medicine rarely explored the programs for more than a minute or two.

The major issue with this exhibit seemed to be that the programs were not designed for use by free-roaming children in an informal, science center setting. They required much more time and attention than most visitors were willing to invest in this setting.

Contributions of Programming within the Exhibition

As noted earlier in this report, while this evaluation included studies of visitors' engagement with the *Exploration Carts* and *Bio Med Tech* theater presentations, these programs were not a primary focus of this study. The purpose of this part of the study was to understand the ways in which engaging with these programs contributed to visitors' understanding of the themes and concepts presented in the *Bio Med Tech* exhibition.

Exploration Carts

The *Exploration Carts* added much-appreciated opportunities for hands-on and interactive experiences to the *Bio Med Tech* exhibition. The data indicated that the *Cart* activities achieved their individual educational goals, and the successive *Cart* programs developed during data collection demonstrated increasing support for the exhibition's major themes and were increasingly effective as entry points to the rest of the exhibition.

In part because of the perceived dearth of interactives, the *Exploration Carts* were well received by families with younger children. For instance, the various DNA activities worked well for different ages: Human Traits for ages six and up, the DNA models for many older children.

> *The woman at the biomedical – the DNA station, she was excellent. It made it very enjoyable. In fact, we'd like to buy [the DNA toy] at the gift shop if they have it.* (080105-09)

> *We're studying [DNA] in school right now….Now we know like a lot more about it.* (080202-08)

Although the DNA cart was usually successful as a stand-alone activity for families, it did not seem to really "launch" most visitors into the exhibition, as was its stated goal. For most visitors, it was a supplement to their experience rather than their starting point for exploring the exhibition. On the other hand, the Medical Imaging activity engaged both children and adults and served as a starting point for thinking about the themes explored in this part of the exhibition.

A challenge for continued *Cart* program development could be to better support the major goals for the exhibition, particularly those goals that were not achieved during the summative evaluation. For instance, develop programming that engages visitors with the concept of biomedical technology, the professions that contribute to this field, and the role that Cleveland plays in developing new biomedical technologies.

Bio Med Tech theater presentations

Public programming in the *Bio Med Tech* theater provided strong support for the exhibition's themes. In particular, these presentations engaged audience members with the concept of biomedical technology, exposed them to the professions that contribute to this field, and highlighted the role that Cleveland plays in developing new biomedical technologies. As discussed earlier in this report, these project goals were only partially achieved by the exhibition during the summative evaluation.

Survey results revealed that the audiences for the three presentations were drawn almost exclusively from the visiting public who had come to GLSC that day for other purposes. Although it may be worthwhile to experiment with ways to attract audience members to come especially for the presentations, it seems likely that a substantial portion of the audience for weekend afternoon programs will be casual visitors to the science center. This should be kept in mind when developing future programming for the theater. The presentations must meet the needs of visitors who learn about the program after they arrive at the museum, who have several competing agendas for their visit, and who are part of complex groups, with visitors of varying ages and interests.

The three programs included in this evaluation varied in their presentation styles and in their success at engaging the complex audience that they attracted. Factors that contributed to the success of theater programs included coaching of the speakers prior to the presentation, limiting the length of the sit-down portion of the program, including of hands-on and interactive experiences during and after the presentations, and effective orientation of visitors who joined the presentations in progress.

The theater was open to the larger *Bio Med Tech* gallery and thus to the science center's core and beyond. Therefore, sound bleed was a problem for both audience members trying to hear the presentation and for visitors who were trying to enjoy the rest of the exhibition.

> *Background noise made it difficult to hear everything.* (080202-02S)
>
> *It would have been very helpful for the speaker and the audience if the acoustics in the room was more contained. Too much extraneous noise.* (080405-07S)

Although the sound system was improved during the evaluation period, the problem of sound bleed will continue to be a challenge.

Because of the open nature of the theater, visitors continued to join the program throughout the formal presentation, question period, and subsequent activities. The latecomers were usually unfamiliar with the goals and themes of the program, which sometimes led to confusion about the meaning and purpose of the post-program activities.

GLSC program staff were given the complete survey data set as a spreadsheet file, so that they can add survey data for subsequent presentations and track the effects of changes made to theater programming.

DISCUSSION: EXHIBITS AS INFORMATION

As noted in the section on the effectiveness of *Bio Med Tech* for different sorts of visitor groups, the researchers encountered quite a few adult respondents who said they really enjoyed the graphics panels in *Bio Med Tech* and who preferred this exhibition to more interactive spaces elsewhere in GLSC. However, a common thread in our discussions with these visitors was the request for *more* information:

> *I felt like the information was a little sketchy. I would like to have had a little more. I wished there had been more information…. The information here is good, but I would like to have had more details.* (080201-08)

> *I guess it would be nice to know a little more in the area with the PET and CT scans. You just have the one set of pictures that shows like a PET and CT and then combined.* (080203-01)

> *I found that a lot of the information was kind of brief. If anything, I didn't have trouble with the technicality of it, but rather with the lack of technicality. Like, a more in-depth explanation of the actual science that was going on would probably be more helpful.* (080404-09)

These visitors were not health care professionals. They were just very interested in health-related issues, and they had read and heard a lot about health care on their own. In the researchers' experience, there are many situations when visitors' requests for more information are really requests for *different* information, because the exhibition in question did not address visitors' real questions about the topic. However, probing questions with these visitors did not lead us to this conclusion about *Bio Med Tech.* These respondents really were extremely interested in topics covered in the exhibition – often because of their personal connections – and they really did want to go beyond the information that was covered in the exhibition.

Of course, one problem with providing these visitors with more depth would be that the text-and-graphics panels would be longer, more difficult to read, and more intimidating for the majority of visitors. Also, there would be no guarantee that the in-depth information selected for the exhibition was precisely what the in-depth readers are looking for. Plus, anyone who stayed long enough to read all that information would likely wind up with sore feet!

That said, several thoughtful respondents made an important point about exhibitions in the age of the Internet – the age of information. As they pointed out, there was no way *Bio Med Tech* could compete with the Internet (or other in-depth references) as a source of information.

> *It's stuff you can see any day on the Internet or anywhere. I didn't see anything really that new.* (080202-06)

> *I could sit at my computer and get the same thing, or read a book…. There's nothing here that I can't find [online].* (080404-01)

These insights lead the researchers to consider the question, "What is the value of constructing exhibits with large numbers of text-and-graphics panels in the age of the Internet?" Here is a list of reasons why this approach can still be of value – why exhibitions can be unique sources of information in the Internet age:

- Text/graphics panels can be integrated with real, three-dimensional objects and hands-on, interactive experiences.

- Science center staff and volunteers can become part of the experience, responding in ways that go beyond what most websites can do.

- Science center experiences are shared with others in visitor groups in ways that go beyond what seems to happen in most homes and schools. In particular, intergenerational sharing within families can be a vital part of science center experiences.

- The information in science center exhibits may compete with dozens of other nearby exhibits, or with the hundreds of exhibits available in a science center, but not with the hundreds of millions of Web pages available through their home computers.

- Visitors "surf" science centers differently than they surf the Web. Many are open to engaging experiences on a range of subjects, rather than focusing on finding specific bits of information.

- Because of these factors, exhibit designers are able to draw visitors into learning experiences that may be unexpected, but ultimately welcome. What's more, teachers and parents – and science center educators – can use exhibitions to motivate their children's interests in new subjects.

Some of the advantages of exhibitions will be diluted as potential Web designers make increasing use of virtual environments, and as Web users (of all ages) become more accustomed to engaging with virtual spaces and objects.

Of course, there are also some disadvantages to including large numbers of graphics panels in a GLSC exhibition:

- Static displays of text and graphics are not really what most people come here for. Most GLSC visitors have different expectations for their visits.

- Text- and graphic-rich exhibitions can be hard for families – even if the adults are interested and engaged by the panels, their children may not be, distracting the adults or dragging them off to other parts of the science center.

- Medical technology is a topic that many visitors can connect with in deeply personal ways. Text-and-graphics panels about other subjects may attract much less attention from GLSC visitors, because other topics have less intrinsic interest to them.

- It's much harder to build effective links between exhibit panels than between Web pages. Thus, related ideas can be harder to connect.

- Because of the limits to what visitors can stand to read and view, the depth of the experience is necessarily limited. Also, it's much more difficult to return to a museum experience than to a local museum. (However, there are indications that motivated visitors are using their digital cameras to record, extend, and revisit experiences that they could not take in completely during their actual visit.)

- Visitors have, at most, a limited chance to respond to what they see. They can talk with their companions, complain to staff, and perhaps respond to a talk-back element, but visitor response is usually a limited part of the overall experience.

- It's difficult and expensive to update exhibitions, other than in a few places like bulletin boards.

So, what can GLSC do about this issue – what should future exhibitions look like in the Internet age? Here are two things to keep in mind:

- Understand your audience – both your target audience for the particular project and the actual audience that will be served by the project. The target audience for *Bio Med Tech* was middle school-aged children through adults, which is a very diverse group in terms of their interests, understanding, and learning styles. However, the *actual* audience (especially when school was not in session) also included large numbers of younger children.

- Find a balance between exhibit media that fits the topic and the target *and* actual audiences for the project. In *Bio Med Tech*, the most effective sections of the exhibition – like Medical Imaging and Prosthetics – achieved that balance. These exhibits achieved their goals and communicated their messages well for all sorts of visitors.

CONCLUSIONS

The *Bio Med Tech* exhibition was partly successful at achieving both its overall goals and the goals for individual sections of the exhibition. It was most successful at achieving goals related to advances in biomedical technology, in part because this theme was reiterated throughout the exhibition. It was less successful at achieving the other main goals, in large part because these were discussed in only a few parts of the exhibition.

Individual exhibit units varied in their success at achieving their stated goals and communicating their intended messages. The Medical Imaging, Prosthetics, and FES exhibits were relatively successful for all ages of visitors, and the Stem Cell exhibits were effective for most adults and many older teens. The Genomics and Infectious Disease sections were less effective for most visitors. The goals in individual exhibit sections were more often achieved when the goals were concrete and only a step or two beyond what most visitors already knew. Exhibits were also more effective when goal-related messages were communicated through a range of media, including hands-on and interactive exhibits, concrete examples of biomedical technologies, and visitor-controlled multimedia.

LESSONS LEARNED AND RECOMMENDATIONS

Overall *Biomedical Technology* Project

Lessons Learned

It was clear that many GLSC visitors were deeply interested in the human body and in the technologies used to explore, diagnose, and cure the medical problems. Their interests went far beyond mere curiosity or academic interests – they were deeply personal in a variety of ways.

Although many teens, some older elementary children, and most adults will read label/graphics panels about topics that interest them, prolonged engagement by younger children, most teens, and less interested adults requires exhibits that are concrete, hands-on, and/or interactive.

Important themes, such as those derived from the main goals of a project, have to be illustrated, reiterated, and reinforced in many places in an exhibition. That is both because most visitors look at only a fraction of the components included in an exhibition, and because understanding complex ideas takes time and extended effort from the learner.

Unfamiliar terms – like "biomedical technology" – should be used with care in exhibitions. If visitors are to learn new terms, they must be defined, illustrated, and used clearly within the context of the exhibits.

GLSC visitors with young children were interested in exhibitions that explain the workings of the human body. With the demise of the Cleveland Health Museum, some visitors perceived a gap in the informal education landscape for this topic and struggled valiantly to make *Bio Med Tech* fill that gap.

Gallery programming can effectively support exhibition goals and, in some cases, supplement an exhibition in ways that help overcome some of its weaknesses.

Recommendations

To better achieve project goals:

Use programming and temporary/changing aspects of the exhibition to better achieve goals two and three (about the broad range of professions that contribute to advances in biomedical technology and the development of new biomedical technologies in Cleveland, at places like Case Western Reserve University). Specific suggestions include:

- Use the *Recent Breakthroughs* bulletin board to display articles that support the themes of the exhibition. This could include more frequent postings that are in a format that looks more like a newspaper or news website posting (so they look more like *news*). In

addition, give preference to articles that (1) include a Cleveland connection, (2) highlight biomedical careers, and (3) give balanced presentations of controversial topics.

- Continue to develop programming that engages children, teens, and adults with the themes of the exhibition. In particular, develop programming that engages visitors with the concept of biomedical technology, the professions that contribute to this field, and the role that Cleveland plays in developing new biomedical technologies.

- Revise the temporary label on the MRI so that it mentions that the Philips MRI has a Cleveland connection.

- Develop one or more additional wall-mounted panels that highlight other Cleveland connections for other medical imaging devices, infectious diseases, and genomics.

As additional funds become available for remediation, develop additional exhibit units that more effectively engage children, teens, and other active learners with the project's main goals. The units should include concrete objects and hands-on and interactive components.

For the speaker presentations in the *Bio Med Tech* theater:

Continue to implement the approaches to these presentations that have contributed to their success, including coaching of the speakers during the weeks before the presentation, limiting the duration of the sit-down portion of the program and including hands-on and interactive experiences during and after the presentations.

Continue to experiment with ways to attract an audience to presentations in the *Bio Med Tech* theater, and then assess the results through surveys.

Continue to experiment with ways to control the sound bleed into (and out of) the *Bio Med Tech* theater.

Experiment with approaches to the theater programs that help latecomers understand the theme of the presentation. For instance, have an explainer quietly greet groups that come late and explain what's going on. For instance, they could give a brief handout to those that arrive during the sit-down presentation with the name of the speaker and an outline of the topics and activities included in the program.

For future exhibition development projects at GLSC:

As outlined in the Discussion section, understand the exhibition's audience – both the target audience for the particular exhibition and the actual audience that will be served by the project.

For future exhibitions, apply Beverly Serrell's Big Idea approach more consistently during all stages of exhibition development and design (1996, p. 1-8).

Make certain the exhibition development/design process effectively applies findings from front-end and formative evaluations.

Avoid the use of unfamiliar terms (or abbreviated versions of unfamiliar terms) in the name of an exhibition.

Find a balance between exhibit media that both fits the topic and serves the target *and* actual audiences for the project.

Make sure that exhibition budgets will support the kinds of concrete, hands-on, and interactive experiences that can effectively achieve the project's goals for the full range of GLSC visitors.

Consider developing a permanent exhibition about the human body targeted at children and their adult caregivers.

Individual Exhibit Units

Recommendations

Medical Imaging:
Label the preserved pig stomach and intestine, so that visitors can learn that it is real but not human.

Infectious Diseases:
For the *Investigation Station*, add an interactive instruction label on the table, and also revise the card design so the instructions are more obvious.

Also for the *Investigation Station*, revise the activity so that one or more clues specifically mentions the use of biomedical technology devices or procedures.

Bio Med Tech **Theater (looped presentations)**:
For future presentations, include both a sound component and on-screen text.

Prosthetics:
For the *Investigation Station*, add a label that identifies and explains the functioning and uses of the prosthetic arm.

Also for the longer term, add additional cases with prosthetic devices along the mostly empty south wall of this area.

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APPENDIX A: PHOTOGRAPHS OF THE EXHIBITION AND PROGRAMMING

The following photographs were taken by Eric D. Gyllenhaal, January through April, 2008.

Figure A-1. Overview of the *Bio Med Tech* exhibition entrance, viewed from the east.

Figure A-2. Overview of the *Bio Med Tech* exhibition entrance, viewed from the west.

Figure A-3. Credit panel, located outside the exhibition entrance, which listed Case Western Reserve University and exhibition advisers by name.

Figure A-4. Center section, which included the *Cleveland Connection*, *Before the Breakthroughs* flat-panel monitor, and case with surgical instruments.

Figure A-5. *Cleveland Connection* panel, which also introduces two Case Western Reserve advisors to the project.

Figure A-6. Overview of *Seeing Inside*, the medical imaging section of the exhibition, along the west wall. The endoscope exhibit is on the left foreground and the MRI in the center.

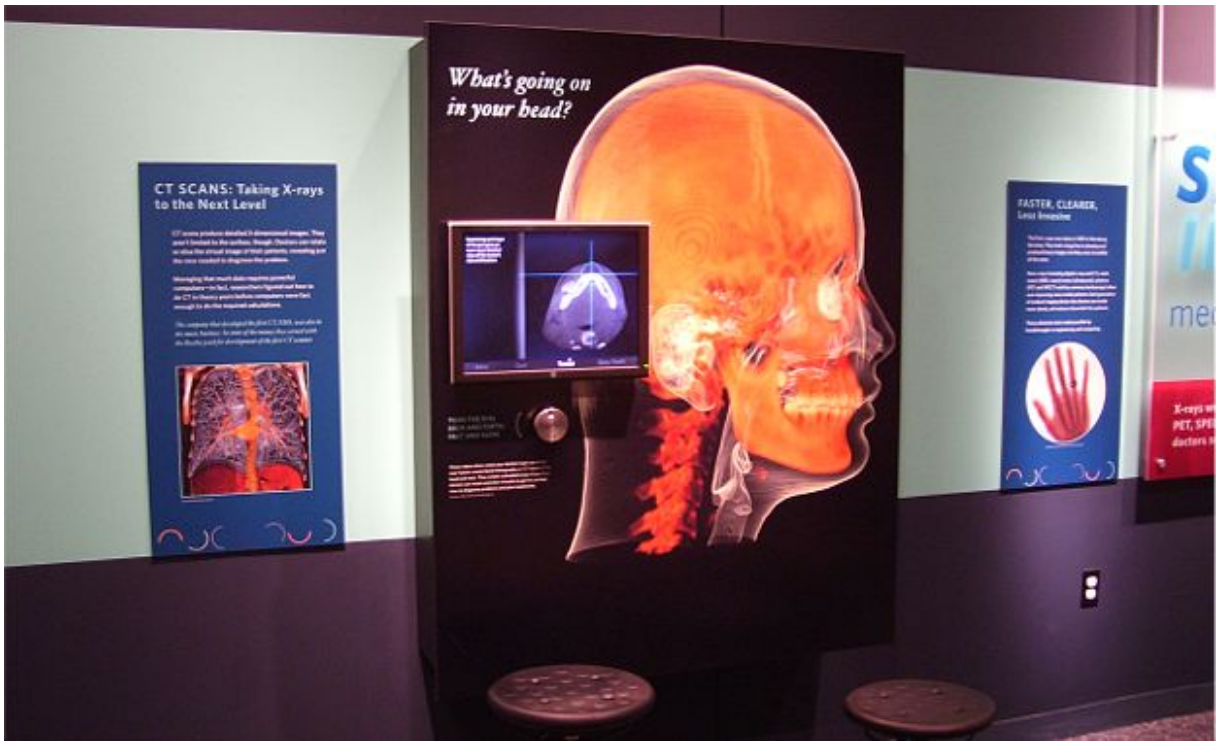

Figure A-7. Center west wall of the imaging section, showing "spinner" that controls CT scan images.

Figure A-8. Southwest wall of the imaging section, showing panels about advances in ultrasound and other advanced imaging techniques.

Figure A-9. *Teams Tools* section, about infectious diseases. *Investigation Station* is right foreground.

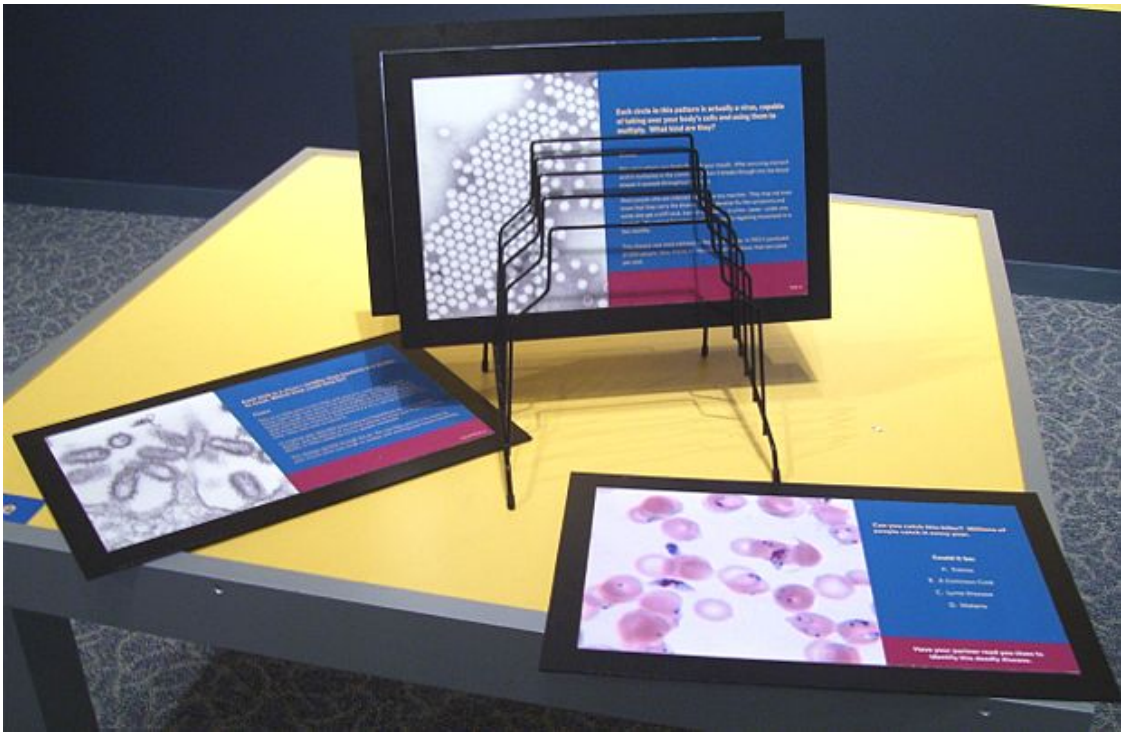
Figure A-10. Closer view of the card activity at the infectious diseases Investigation Station. Cards on left and center show the side with clues; card on lower right shows side with potential answers.

Figure A-11. *Bio Med Tech* Theater, on the south wall of the exhibition (between infectious disease and prosthetics sections).

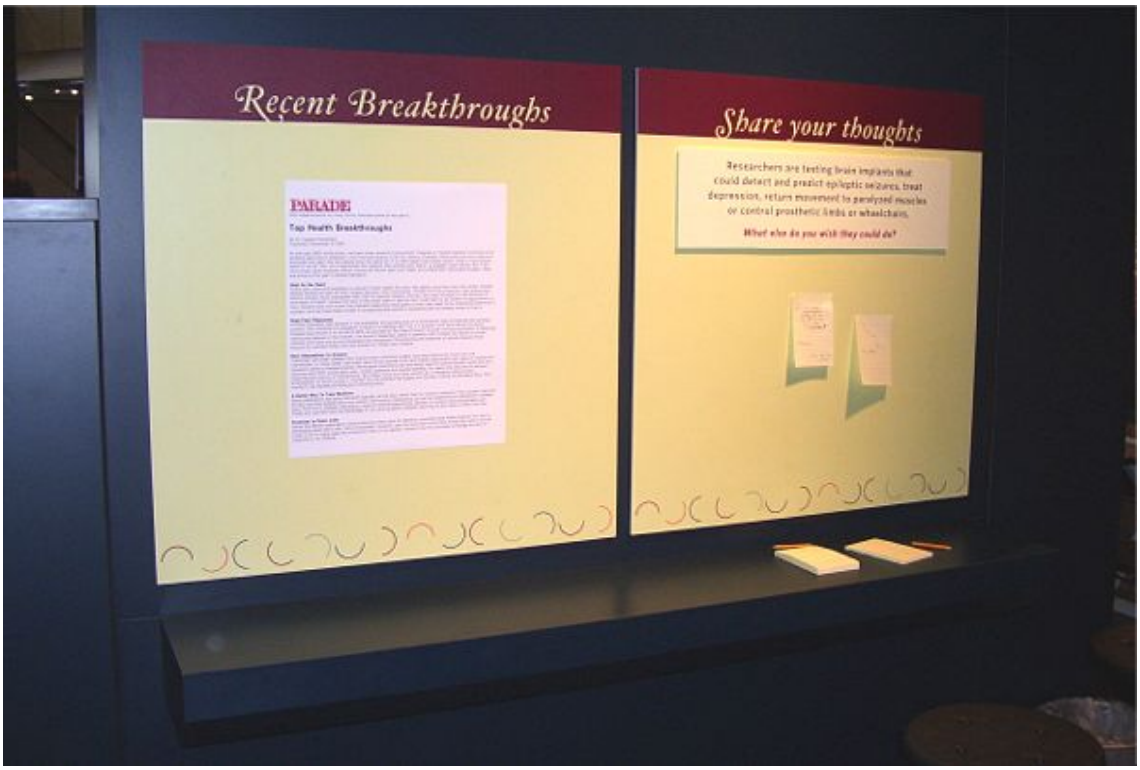

Figure A-12. Bulletin boards located on the back of the center section (Fig. A-4). The board for articles about recent breakthroughs is on the left, *Share Your Thoughts* talk-back on right.

Figure A-13. *Share Your Thoughts* talk-back board covered with sticky notes on a busy Saturday.

Figure A-14. Overview of the *Advances in Prosthetics* section (opposite FES in the southeast corner of the exhibition).

Figure A-15. Overview of the *FES* section (wall panels on left, island exhibits on right).

Figure A-16. FES panels on the east wall of the exhibition. Note video panel, second from right.

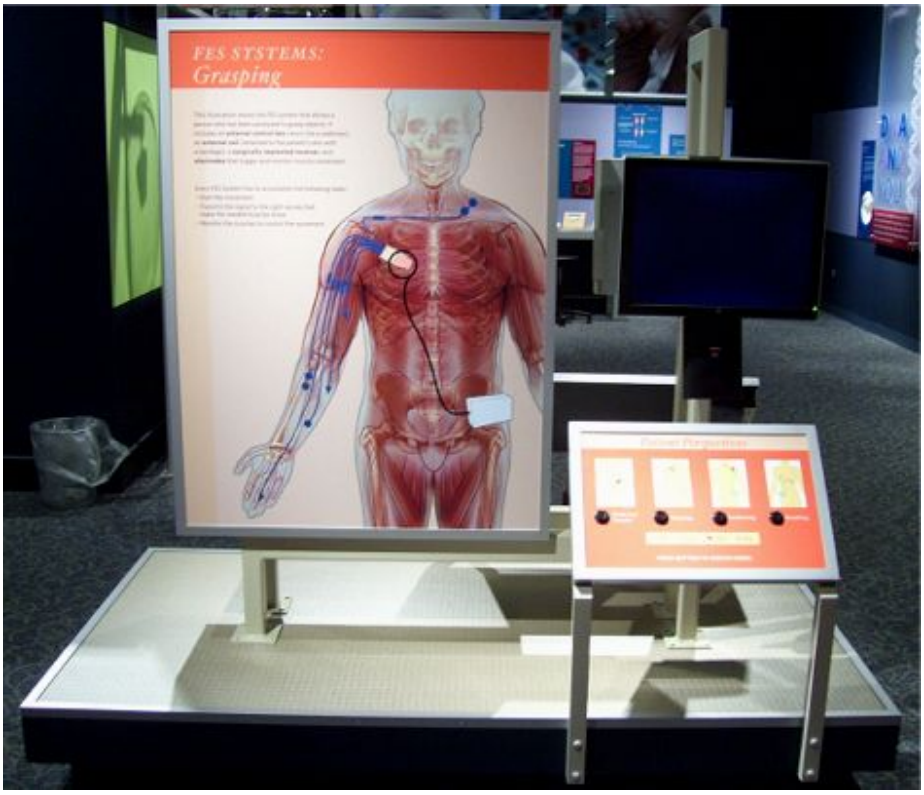

Figure A-17. Additional FES panels and multimedia on an island just west of the FES wall panels.

Figure A-18. Overview of *Stem Cells* and *FES* sections, southeast corner of the exhibition.

Figure A-19. Stem Cell panels on the east wall of the exhibition.

Figure A-20. Additional Stem Cell panels and multimedia on an island just west of the Stem Cell wall panels.

Figure A-21. Overview of the *Genomics* section, entitled *DNA and You*.

Figure A-22. DNA matching activity in the *Genomics* section.

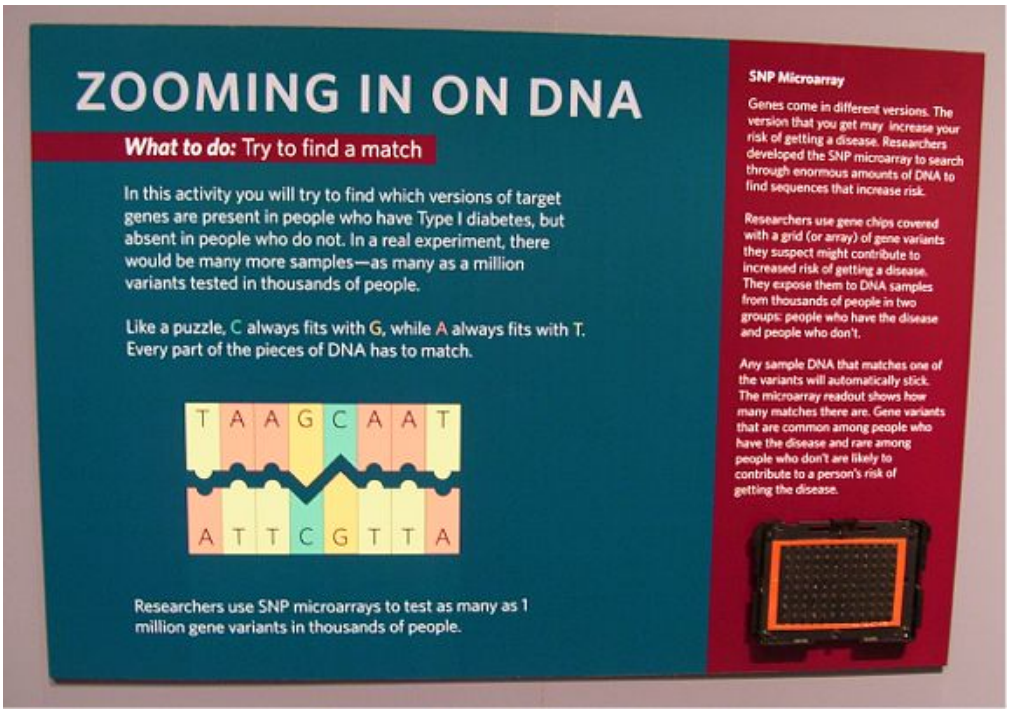

Figure A-23. Wall mounted instruction label for DNA matching activity. Note SNP microarray in lower left corner of panel.

Figure A-24. *Health Careers Quest* module, with two computer stations that display programs about health careers and women in science.

Figure A-25. *Bio Med Tech Exploration Cart* set up for the DNA activities.


Figure A-26. *DNA Exploration Cart* activities. A (on left). DNA construction activity. B (on right). Genetic traits activity (white cards) and twistable DNA model.

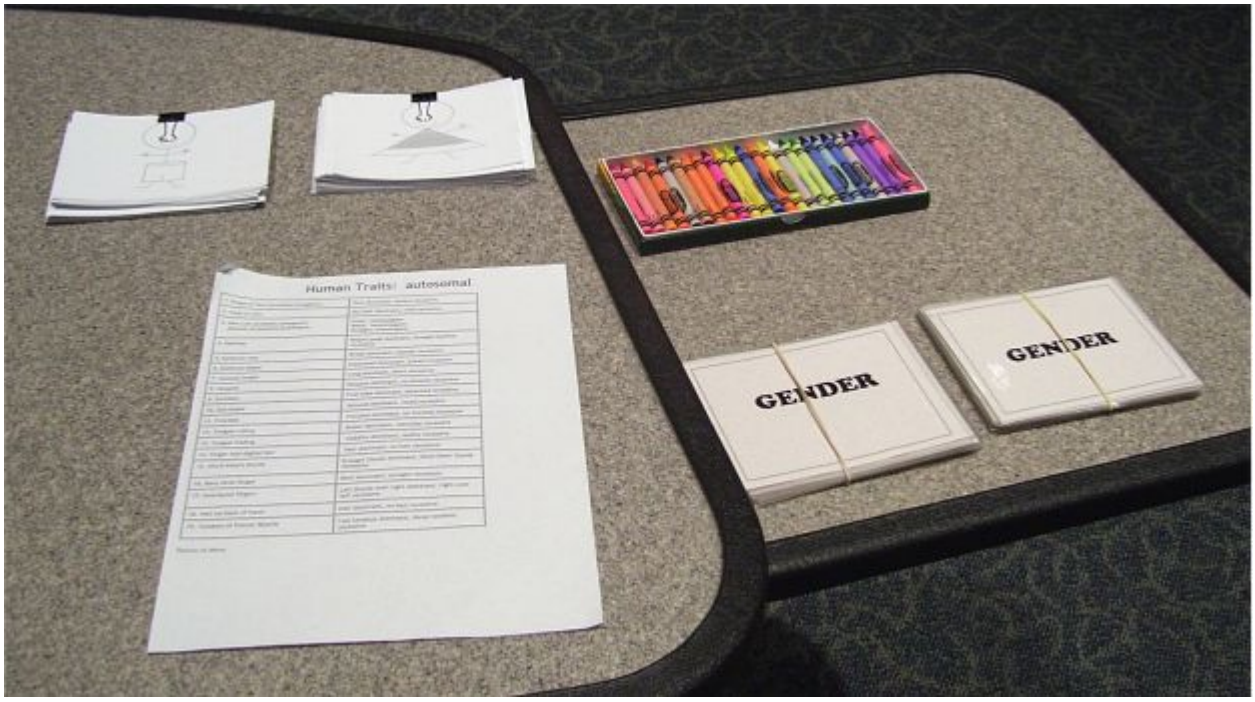

Figure A-27. *Human Traits* activity at the *DNA Exploration Cart*.


Figure A-28. *Medical Imaging Exploration Cart* activities. A (on left). Cart set up with sealed boxes and clues. Note CT scans on screen. B (on right). Box opened to show solution to puzzle.

Figure A-29. *Bio Med Tech* theater set up with extra benches for the April presentation on FES.

Figure A-30. Hands-on activities set up in the *Bio Med Tech* theater for the April presentation on FES.

APPENDIX B: TOPICAL FRAMEWORK

Topical Framework for the
Remedial/Summative Evaluation
of the Great Lakes Science Center
Biomedical Technology Exhibit

Selinda Research Associates, Inc.
12/28/07

A topical framework is a list of issues or topics we will explore during the remedial/summative evaluation. It is phrased as a series of questions we will try to answer by observing and talking with visitors as they explore the *Bio Med Tech* exhibition and its included programming. (Note: These are questions we will answer during the study, not the questions we will ask visitors.)

Research Question

In what ways and to what extent did the *Bio Med Tech* exhibition and programming achieve the four major visitor goals (listed in Appendix A)?

Topical Framework Questions

Overall Description of the Exhibition and Programs

How was the exhibition organized, and what did it look/sound/feel like?

- What did the exhibition look/sound like as visitors approached it?
- What were the major areas of the exhibition, how were they delineated, and what individual exhibits did they include? What sorts of objects, equipment, multimedia, interactive/manipulatives, graphics, and label texts were included in each section of the exhibition, and how did they interrelate?
- What was the theater space like (including the seating), and what sorts of multimedia presentations took place within the theater?
- What were the Investigation Stations like, where were they located, how were they organized and explained, and what sorts of specimens, equipment, and graphics accompanied the activities?

How was the cart programming organized, and what were the cart activities like?

- How were the individual cart activities organized? What materials were available, and how did staff facilitators use them? How long did they take to complete, and what happened during an activity?
- Who were the facilitators, and what were their backgrounds and training?
- How often/long were the cart activities scheduled each day? Where were they located within the exhibition?
- What kinds of specimens, equipment, expendables, and graphics were part of the activities?
- Which exhibit(s) did the activities relate to, and how were they referenced during the activities?

How was the BMT *theater programming organized, and what did the programs look and sound like?*

How were the *BMT* theater presentations organized? What times were they, and how long did they last? What was the balance of formal presentation, question-and-answer period, and post-presentation meeting/talking with the speaker?

How was the audience recruited/informed of the presentation? How were they seated?

Which exhibit(s) did the presentations relate to, and in what ways were the exhibits referenced during the presentation?

Visitor Engagement

In what ways and to what extent were visitors engaged within the BMT *exhibition?*

What sorts of physical, social, intellectual, and emotional engagements did we see, and how do these compare with the intended engagements?

How did visitors engage physically? To what extent was there standing, sitting, looking, reading, pointing, touching, manipulating dials, and other forms of physical engagement? In what ways and to what extent did visitors engage with various components of the exhibition (e.g., equipment, objects, multimedia, interactives, news articles, and graphics/labels)? Which texts did visitors read, and at what point in their engagement with each exhibit component did they read them?

How did visitors engage emotionally? To what extent was there pride, surprise, satisfaction, excitement, passion, enjoyment, frustration, confusion, intimidation, and other forms of emotional engagement? In what ways and to what extent did potentially controversial issues contribute to visitors' emotional engagement?

How did visitors engage intellectually? In what ways did visitors think about, process, make connections, and make meaning of their experiences? To what extent were visitors being thoughtful and reflective? In what ways did the different components of the exhibition contribute to visitors' intellectual engagements?

How did visitors engage socially? When and with whom did visitors engage? In what ways and to what extent did social engagements facilitate and contribute to visitors' learning and enjoyment? To what extent were there teaching/learning interactions? To what extent were there appropriate directing attention, asking questions, explaining phenomena, and other ways of guiding the learning process? Who was leading these teaching/learning interactions? How sophisticated were the visitors' dialogues with the GLSC facilitators, and what role did these play in their overall experience?

Design of Exhibits and Programming

How effective were the designs of the exhibits and programs?

What did visitors engage with *first* – what seemed to draw them into the exhibition and launch them into their engagement? Did the design encourage visitors to spend time in every section of the exhibition? What entry or launch points to the exhibition were most effective, and for whom?

In what ways and to what extent did the various exhibit components and program elements enhance visitors' understanding of the messages? What did visitors say was clear/unclear about the exhibits/programs? Did any components detract from the message or cause visitors to become confused or frustrated?

Was there an appropriate balance among the various types of exhibit components (especially for the target audiences)?

Did the interactives feel intuitive, or were interactive instructions clear and concise when they were needed? How quickly were visitors able to figure out how to use the interactive exhibits, and how often did they walk away frustrated? What needs to be better explained or clarified, or redesigned to feel more intuitive?

To what extent was physical accessibility an issue (e.g., were the touch screens physically accessible for those with mobility problems, and did there need to be captions on the multimedia for deaf/hard of hearing and others)?

Did visitors feel some topics were too controversial, or were presented in unfair ways?

What aspects of the exhibits and programs were most appreciated by members of the various target audiences and by others in their groups? Which aspects were least appreciated, or least useful to them?

Visitor Interest and Knowledge

What were visitors' interests in and attitudes toward the content of the programs?

How did visitors describe their interests in and attitudes toward the biomedical technologies and to BMT scientists, engineers, physicians, and others on BMT development teams?

What piqued visitors' curiosity and stimulated their interests? To what extent and in what ways did the exhibits and programs get visitors more excited about these topics and interested in learning more about them?

What evidence was there that visitors changed their attitudes toward BMT, BMT research, and/or BMT careers?

How did the exhibits and programs support, contribute to, and influence visitors' interests in BMT? In what ways and to what extent did the exhibits and programs fail to support or dampen visitors' interest and curiosity?

In what ways and to what extent did visitors gain knowledge, correct misconceptions, or deepen their understanding of BMT?

What evidence was there that visitors progressed along various knowledge hierarchies related to BMT (as defined during the front-end evaluation)?

What messages were visitors walking away with?

What words did visitors use as they talked about exhibits and programs?

What messages about BMT came across to visitors? Which messages *stuck* with them as they left, and after they had returned home? What messages did visitors carry away about the research/interdisciplinary teams developing and improving biomedical technologies?

To what extent and in what ways did visitors understand the concepts presented in the exhibits and programs? Were there significant misconceptions about or alternative understandings of these concepts? (e.g., did the focus on limbs in prosthetics leading visitors into too narrow a vision of what prosthetics are?)

What kinds of questions did visitors ask within the exhibit and during programs? Did the exhibits and programs answer questions visitors came with or developed during their visit? What unanswered questions did visitors still have when they left the exhibition and programs?

In what ways did visitors relate the exhibits and programs to their daily lives?

How did visitors tie the messages about BMT to their personal lives? What personal connections to biomedical technologies did respondents express, and how were their feelings of connection modified or expanded through participation in *BMT* exhibits and programs?

In what ways, and to what extent, did visitors recognize and value connections between the biomedical technologies and other people in their lives, be they family, friends, or others?

To what extent did visitors feel personally connected to people on BMT development teams, and how did that impact their feelings about BMT? To what extent were these connections facilitated by opportunities for personal contact with researchers (e.g., through live theater presentations)? What did students and younger visitors have to say about BMT careers and about science/engineering/medical careers in general?

For whom did the exhibit and program experiences seem to work particularly well?

What kinds of audiences, group composition, ages, pre-existing interests, and experience seem to facilitate a good experience? For which audiences were they not as successful?

Visitor Enjoyment

How did visitors appear to be enjoying themselves?

To what extent and in what ways was this an enjoyable experience for visitors? In what ways and to what extent did visitors feel challenged, motivated, curious, and playful? What did they enjoy the most? The least?

What did they appear to be frustrated by and/or unhappy with? In what ways and to what extent did visitors feel satisfied and/or unsatisfied with their BMT experience?

In what ways and to what extent were visitors comfortable with the exhibits and programs, with exhibit amenities (such as seating), and with approaching GLSC staff and theater presenters?

Visitor Use of the Cart Activities and Theater Presentations

In what ways were visitors involved in the cart activities?

Who self-selected to participate during the cart activities and theater presentations? Who declined to participate? What factors seemed to play a role in their decisions?

What did visitors do during cart activities? How did they attend and react to the activities?

What relationships did visitors see or draw between the cart activities and the exhibition? To what extent were visitors using the cart activities as alternative entry point into the exhibition (especially for children)?

What did visitors take away from the theater presentations?

Were the presentations a success in terms of numbers attracted, how long people stayed, and how many stayed afterwards to ask questions? How did people hear about the presentation, and in what ways did that influence their perceptions of the event?

What did visitors do during and after presentations? How did they attend and react to the presentations? What questions did they ask and what topics did they discuss with the presenter after the formal presentation?

What relationships did visitors see or draw between the presentations and the exhibition? Did visitors go to the (for example) imaging exhibits before/after the expert talks?

What was the presenter's perspective on the audience's experience?

Visitor Engagements with GLSC Staff Facilitators

What did visitors gain from their interactions with facilitators?

In what ways and to what extent did visitors interact with the facilitators? To what extent were there teaching/learning interactions? To what extent was there appropriate directing attention, asking questions, explaining phenomena, and other ways of guiding the learning process by facilitators? How sophisticated were the visitor dialogues with facilitators?

Which aspects of the cart activities seem to stimulate the most interactions with facilitators? Did different activities or components seem to stimulate qualitatively different interactions with the facilitators?

Visitor Attitudes toward Biomedical Technology

What were visitor attitudes toward the technologies showcased in the exhibitions and programs?

Were any technologies considered too controversial by visitors and, if so, how did they react to the ways these were presented within the exhibition?

Did visitors feel that their own viewpoints were represented and/or accepted within the context of the exhibition? If so, why did they react as they did?

How did reception of the BMT exhibits and programs vary among the various target audiences?

What aspects of the exhibits and programs were most appreciated by members of the various target groups (e.g., middle and high school students; adults)? Which aspects were least appreciated, or considered least interesting or useful to them, and why?

Project Goals

Which goals did the BMT *project achieve?*

In what ways and to what extent did the *BMT* exhibits and programs achieve their stated goals (see Appendix A)? Which exhibit components and programming elements contributed to achieving the goals, and in what ways did they do so?

In what ways and to what extent did the project achieve the sorts of informal education goals listed in the Report of the Academic Competitiveness Council (e.g., increase awareness, interest, engagement, and understanding of STEM concepts, processes, and careers by the general public and other targeted populations)?

For which audience members (target and otherwise) were the goals achieved, and why?

APPENDIX C: SAMPLE DATA COLLECTION PROTOCOLS

Bio Med Tech at the Great Lakes Science Center
Brief Overview of the Remedial/Summative Evaluation Process

December 31, 2007
== Version 01 ==

Step 1. Post signs.
Make sure signs are posted at each entrance to the area where you will be conducting observations and interviews.

Step 2. Select respondent(s).
Use purposive sampling of intact visitor groups. Record why you selected each group.

Step 3. Observe respondent(s) using the exhibits.

Step 4. Invite respondent(s) to participate in an interview.
If they say no, write up observations and then go back to step 2.

Step 5. Introduce respondent(s) to the interview process.
Include all pertinent information.

Step 6. Interview the respondent(s) and take notes.
Use Interview protocol. Ask probing questions as necessary/appropriate.

Step 7. Invite respondents to talk again by phone later.
If they accept, have them complete a follow-up survey form.

Step 8. Thank respondent(s) and give them a gift.
Be generous in your appreciation.

Step 9. Complete your observation and interview notes.
Fill in and flesh out any missing items.

Step 10. Complete debrief for this observation/interview.
Do this BEFORE your next observation and interview.

Step 11. Enter respondent information on the Respondent Data Sheet.

Step 12. Go back to Step 2 and begin another round of data collection.

***Bio Med Tech* Remedial/Summative Observation Protocol**

Step 3. Observe respondent(s) using the prototype and take notes.

Date: _____ Obs # _____ Initials: _____

Start Time: _____AM/PM End Time: _____AM/PM

Group Type

1 alone
2 two adults
3 several adults
4 tour group
5 adults with children
6 camp/school group

Group Size / Ages:

Members? Y N

Ethnic Category:

___ H/L-F = Hispanic or Latino female
___ H/L-M = Hispanic or Latino male
___ N-F = Not Hispanic or Latino female
___ N-M = Not Hispanic or Latino male

Racial Categories:

___ A-F = Asian female
___ A-M = Asian male
___ B-F = Black or African American female
___ B-M = Black or African American male
___ W-F = White female
___ W-M = White male
___ AI-F = American Indian or Alaskan Native female
___ AI-M = American Indian or Alaskan Native male

Why did you select this respondent group?

NOTES: (add more on the back if necessary—or use a separate notebook)

***Bio Med Tech* at the Great Lakes Science Center**

Step 4. Invite respondent(s) to participate in the study.
The introductory statements might go something like this:

Hi, I'm _____, and I'm working with Great Lakes Science Center to help them figure how this new exhibit is working. We are talking to visitors about the new exhibit, and I was wondering if I could talk with you for a few minutes. It's completely voluntary – you don't have to participate. It will take about __ minutes to participate in the study. Would you be willing to participate?

[If yes.]

Everything you say is confidential, and you don't have to give your name unless you really want to. There are no right or wrong answers, because we want to find out what you think about the exhibit. We need you to tell us what you really think so we can make sure it works for the people who come here. We're finding out about how well the exhibit works, not testing you. If something about the exhibit isn't working for you, then we need to fix the exhibit.

By the way, we don't work for the science center. We are testing this for the science center, so you can say anything you want to about the exhibit—you don't have to worry about hurting our feelings.

We want to find out as much as we can talking with you, but if we end up taking too much time, we can stop the interview at any time—just let us know you want to stop.

.

Step 5-9. *Bio Med Tech* Remedial/Summative Interview Protocol
Date: _____ Obs # _____

Introduction: We'll ask you some questions:

- no right or wrong answers
- trying out the exhibit, not testing you
- stop at any time
- [chit chat to get visitors relaxed]

1. Have you ever visited GLSC before? Y N
   What about this exhibit? Y N

   Who else is here with you today?
   What ages are the children who are with you today?
   May I ask where you're from?

2. I noticed that you were _____.

   Can you tell me more about what you were doing and thinking? [What got you thinking about that?]

3. When you finished using this exhibit, what things were going through your mind?

   What unanswered questions did you have?

4. What is something new [that you think your child found out at this exhibit that they didn't know before]?

   What did you find out?

   [If appropriate] How would you explain this to somebody else?

5. Can you tell me about any special interest or expertise in this area?

6. Rate this exhibit from 1-10 (1 is the worst and 10 is the best) compared to other exhibits you've seen in science centers. Why did you give it this rating?

7. That's all the questions I have. Do you have any questions for me?

Thank respondent(s) and give them a gift.
Thank you very much for your time. Here's a small token of our appreciation.

Step 10A. *Bio Med Tech* Remedial/Summative Engagements Debrief
Date: _____ Obs # _____

For each item, rate the overall quality of the group's engagement relative to the team's intentions on a scale of 0 to 4. (4 highest level, 0 is no engagement). Explain why you gave that rating, give specific examples, and note how the exhibit facilitated these engagements.

Physical Engagements: 4 3 2 1 0

Intellectual Engagements: 4 3 2 1 0

Social Engagements: 4 3 2 1 0

Emotional Engagements: 4 3 2 1 0

Step 10B. *Bio Med Tech* Remedial/Summative Debrief (continued)

Answer these questions as part of your written debrief:

1. What was special about this observation/interview?

2. What aspects of the exhibition/programming attracted visitors' interest and seemed to stimulate their curiosity?

3. Which aspects of the exhibition did visitors particularly enjoy using? Which exhibits didn't seem as enjoyable, and why?

4. In what ways were people playing in the exhibition? In what ways, if any, did that contribute to their making sense of, and understanding, the exhibits?

5. What aspects of the exhibition stimulated meaningful conversations? What were those conversations about, and who were they with? To what extent were they personal narratives? To what extent did they involve ethical or controversial issues?

6. What sorts of teaching/learning interactions did you see? What aspects of the prototype seemed to stimulate or support these sorts of interactions?

7. In what ways did the respondents seem to connect to the exhibit material and ideas in a personal way (beyond likes and dislikes)?

8. To what overall extent did this group achieve the team's goals?

9. To what extent, and in what ways, did this group understand the intended messages?

10. What three things did you learn from this respondent group? What did you find out that you didn't know before?

11. Did the observation/interview raise any new questions?

12. What about the exhibit ion seems to be working well, and why? What is not working as well?

13. How might the exhibition be revised to make it more effective for this group?

14. What larger lessons did you learn that apply to remediating the exhibition or planning future exhibitions at GLSC?

APPENDIX D: THEATER PROGRAM SURVEY

(This is a slightly re-formatted version of the April, 2008 survey.)

PLEASE COMPLETE THIS ONE-PAGE SURVEY ABOUT TODAY'S PROGRAM

1. How did you first find out about today's program?
   ____ Received an e-mail ____ Heard announcement in Science Center
   ____ Read in a handout ____ Science Center staff told me personally
   ____ Other: Please describe: _____

2. Please complete this sentence: "Before this program, I never realized that.…"

3. What was the best part of the program for you, and why?

4. What aspect of the program could have been better for you, and why?

5. Please list additional topics and speakers that you would like to see included in this speaker series. (Use the back of this sheet if necessary.)

6. Is there anything else you want to tell us about today's presentation?

7. Your profession: _____

8. Your zip code: _____

9. How many people are in your group? _____

Check if you came with: Family_____ Friends_____ Larger group_____

Check if your group includes children: 5 and under____ 6 to 12____ Teens____

APPENDIX E: DESCRIPTION OF RESPONDENTS

Summary by Data Collection Method

Type of Data Method	Individuals	Groups
Unobtrusive observation only	171	35
Observation and interview	263	50
Interview only	5	5
Participant observation with interview	5	3
Post-presentation written survey	39	37
Totals:	*483*	*130*

Descriptions of Respondent Groups Observed and Interviewed in the Exhibition

			Group Composition				Ethnicity				Racial Categories							
Date	#	Total	AF	AM	CF ages	CM ages	H/L-F	H/L-M	N-F	N-M	A-F	A-M	B-F	B-M	W-F	W-M	Type	Prog.
0103	1	2		1	7				1	1					1	1	Ob	
0103	2	2	1			10			1	1	1	1					Ob	
0103	3	2				7, 10				2						2	Ob	
0103	4	2				6, 7				2						2	Ob	
0103	5	2	1		18				2		1				1		ObI	DNA
0103	6	2	1		6		1		1						2		ObI	DNA
0103	7	2	1	1					1	1					1	1	Ob	
0103	8	3	1		5	9			2	1					2	1	Ob	
0103	9	5	2	1	4, 5				4	1					4	1	ObI	
0104	1	1	1						1						1		I	
0104	2	1	1						1						1		I	
0104	3	19	2		12 x 7-9	5 x 7-9			7	12			1	1	6	11	Ob(I)	
0104	4	1		1						1						1	ObI	DNA
0104	5	2	2						2						2		ObI	
0104	6	2	1	1					1	1					1	1	ObI	
0104	7	2	1	1					1	1					1	1	ObI	
0104	8	5	1		12, 8, 3	5			4	1					4	1	ObI	DNA
0104	9	9	3			6 x 7-10			3	6					3	6	ObI	DNA
0104	10	2	1	1					1	1			1	1			ObI	
0105	1	4	1	1	8	14			2	2					2	2	Ob	
0105	2	4	1	1	6	3			2	2					2	2	Ob	
0105	3	1	1						1						1		ObI	
0105	4	3	1		8	7			2	1					2	1	ObI	DNA
0105	5	3	1	1	18				2	1					2	1	Ob(I)	DNA

Date	#	Total	Group Composition				Ethnicity					Racial Categories					Type	Prog.
			AF	AM	CF ages	CM ages	H/L-F	H/L-M	N-F	N-M	A-F	A-M	B-F	B-M	W-F	W-M		
0105	6	4	1	1		14, 9			1	3					1	3	Ob(I)	DNA
0105	7	5	1	1	15	9. 12			3	2					3	2	Ob	DNA
0105	8	2	1			17			1	1					1	1	Ob	
0105	9	2	1			13			1	1					1	1	ObI	DNA
0105	10	4	1	1		6, 8					2	2					Ob	DNA
0105	11	4	2	2					2	2					2	2	Ob(I)	DNA
0105	12	2	1	1					1	1	1	1					ObI	
0105	13	2	1	1					1	1					1	1	Ob	
0105	14	2	1	1					1	1					1	1	Ob	
0105	15	5	1		10, 8, 5	3			4	1					4	1	Ob	
0106	1	3		1	8	9			1	2					1	2	ObI	
0106	2	3	1		6	9			2	1	1	1			1		ObI	DNA
0106	3*	5	3	2					3	2					3	2	Ob	
0106	4	2		1	5				1	1					1	1	Ob(I)	
0106	5*	3	2	1					2	1					2	1	PO	
0106	6	4	1	1	10	12			2	2					2	2	ObI	
0106	7	2		1	8				1	1					1	1	ObI	
0106	8	3	2			5			2	1					2	1	ObI	
0201	1	103+	3		~50 7th g	~50 7th g	2	1	50	50			2	1	50	50	Ob(I)	DNA
0201	2	1	1						1						1		I	
0201	3	1	1						1						1		I	
0201	4	2		1		7				2						2	ObI	
0201	5	2	1			8			1	1					1	1	ObI	
0201	6	2	1	1					1	1					1	1	ObI	DNA
0201	7	3	1	1		15			1	2					1	2	ObI	
0201	8	3	2	1					2	1					2	1	ObI	
0201	9	2	1		~4				2						2		Ob(I)	
0202	1	7	2	1	2 x 15-18	2 x 15-18			4	3					4	3	Ob(I)	
0202	2	4	1	1	4	2			2	2					2	2	ObI	
0202	3	2	1	1					1	1					1	1	ObI	
0202	4	5	1	1	11, 11	14			3	2					3	2	ObI	
0202	5	6	1	1	7, 8	3, 10			3	3					3	3	Ob(I)	DNA
0202	6	2	1	1					1	1					1	1	ObI	
0202	7	22	7	7	1	7			8	14					8	14	Ob	Theater
0202	8	4		1	3 * 11				3	1					3	1	ObI	DNA
0202	9	4	2	1		9							2	2			ObI	Image
0203	1	1		1						1						1	ObI	
0203	2	3	1	1	5				2	1					2	1	Ob	~DNA
0203	3	3	1	1	~7				2	1					2	1	Ob	~DNA

Date	#	Total	Group Composition				Ethnicity				Racial Categories						Type	Prog.
			AF	AM	CF ages	CM ages	H/L-F	H/L-M	N-F	N-M	A-F	A-M	B-F	B-M	W-F	W-M		
0203	4	2		1	16				1	1					1	1	Ob/PO/I	
0203	5	3	1			~8, 14			1	2					1	2	Ob	
0203	6	4	1	1	8	12			2	2					2	2	Ob	
0203	7	1	1						1		1						ObI	
0404	1	1	1						1						1		I	
0404	2	1		1						1						1	ObI	Image
0404	3	13	1	1	12 y x 5, 8	12 y x 5			7	6					7	6	Ob	Image, DNA
0404	4	2	1	1					1	1					1	1	ObI	
0404	5	3		1	7, 9				2	1			2	1			Ob	Image
0404	6	3	1	1		7			1	2					1	2	ObI	Image
0404	7	4	1	1	3, 4				3	1					3	1	ObI	Image
0404	8	6			2 HS	4 HS			2	4					2	4	Ob	
0404	9	2	1	1					1	1					1	1	ObI	
0404	10	4	1		12, 10	8			3	1					3	1	ObI	
0404	11	2	1	1					1	1					1	1	ObI	
0404	12	2	1						1	1	1					1	ObI	
0405	1	36			9	27			9	27					9	27	Ob	
0405	2	4	2	2					2	2					2	2	Ob	
0405	3	2			17	17			1	1					1	1	Ob	
0405	4	2	1	1					1	1					1	1	Ob	
0405	5	3	1		8, 9				2	1					2	1	ObI	Image, FES.
0405	6										1	3					Ob	FES
0405	7*	9	3	2	12, 8	8, 10			5	4					5	4	Ob	N/A
0405	8*	20	4	3	4 *	9 *			8	12					8	12	Ob	N/A

* This number included more than one group (generally because one or more originally separate groups interacted with the others during an observation).

KEY

Date = MM/DD

= Interview number

Total = Total number in group

Group composition:

AF = Number of adult females in group

AM = Number of adult males in group

CF = Ages/grades of female children in group

CM = Ages/grades of male children in group

Ethnicity (if left blank, no members of that group were identified as Hispanic/Latina or Latino):
- H/L-F = Number of Hispanic/Latina females in group
- H/L-M = Number of Hispanic/Latino males in group
- N-F = Number of Non-Hispanic/Latina females in group
- N-M = Number of Non-Hispanic/Latino males in group

Racial categories (no visitors of American Indian descent were identified during the study:
- A-F = Number of Asian or Asian American visitors in group
- A-M = Number of Asian or Asian American females in group
- B-F = Number of Black/African females in group
- B-M = Number of Black/African males in group
- W-F = Number of White/Caucasian females in group
- W-M = Number of White/Caucasian males in group

Type = Type of observation or interview
- Ob = Observation only
- ObI = Observation and Intercept Interview (the I is in parentheses when the interview was very brief)
- I = Depth Interview only
- PO = Participant Observation

Progr. = Name of program participated in
- DNA = DNA Cart
- Image = Imaging Cart
- Theater = Theater Presentation
- [blank] = Did not participate in a program