Underground Adventure
Summative/Remedial Evaluation

The Field Museum

Selinda Research Associates
Chicago, Illinois

April 2002

Jane Schaefer
Deborah L. Perry, Ph.D.
Eric D. Gyllenhaal, Ph.D.

Acknowledgments

We would like to thank Francie Muraski-Stotz, Barbara Ceiga, and the exhibit development staff of *Underground Adventure* for their help and thoughtful feedback during this evaluation. We also thank the National Science Foundation for its generous support of this project.

We most gratefully acknowledge all the visitors who participated in this study. Their willingness to interrupt their visits to The Field Museum and give so generously of their time is greatly appreciated.

Table of Contents

Executive Summary ____ *1*

Team Summary ____ *4*

Introduction ____ *17*

- **Overview** ____ 17
- **Research Questions** ____ 17
- **Description of the Exhibition** ____ 17
- **Goals and Objectives of Exhibition** ____ 18
- **Definitions** ____ 19
- **Language** ____ 19
- **The Researchers** ____ 20
- **Limitations of the Study** ____ 21

Methodology and Methods ____ *23*

- **Overview** ____ 23
- **Depth Observations** ____ 24
- **Evaluation Meetings** ____ 25
- **Unobtrusive Observations** ____ 26
- **Depth Interviews** ____ 26
- **Exhibition Discussion Group** ____ 27
- **Group Debrief Meetings** ____ 28
- **Data Citations** ____ 28

Results and Analysis 1 – The Visitor Experience ____ *29*

- **Overview** ____ 29
- **Enjoyment** ____ 29
- **Time In Exhibition** ____ 32
- **Learning** ____ 33
- **Messages** ____ 36
- **Engagement** ____ 40
- **Personal Connections** ____ 45

Respondents' Perceptions of the Exhibition's Intended Audience 51

The Experience for Families with Children Age Five and Under 53

Results and Analysis 2 – Areas of the Exhibition *56*

Overview 56

Advance Organizer 56

Base Camp 57

Underground Experience 57

Mud Room 62

Connections 65

Theatre 65

Conclusions 67

Results and Analysis 3 – Exhibit Units *71*

Overview 71

Penny and Rulers 71

Teaspoon of Soil 72

Movement Video 72

Mole Tracking Station 73

Cicadas 73

Conclusions *74*

Overview 74

The Visitor Perspective 74

The Museum Perspective 76

Recommendations *79*

Overview 79

Level 1 Recommendations 79

Advance Organizers 79

Families with Children Age Five and Under 80

Crowds and School Groups 81

Conclusions Area 81

Cicadas 82

Fear 82

Mud Room 83
Connections 83

Level 2 Recommendations 83
Composting 83
Mole Tracking Station 83

Level 3 Recommendations 84
Social Interaction 84
Reverse Shrink Chamber 84
Theatre 85
Quotes 85
Touching Soil 85
Soil Lab Fantasy 86

***References* 87**

***Appendices* 90**

Appendix A: List of Exhibit Names 90

Appendix B: Overview of Depth Observations 103

Appendix C: Debrief Example 105

Appendix D: Observations and Interviews 109

Appendix E: Topical Framework 110

Appendix F: Research Questions 113

Executive Summary

Introduction

Underground Adventure opened at The Field Museum in March 1999. Covering 15,000 square feet, it continues to be a major draw in the museum. Determining the extent to which the exhibition is achieving its original goals and assessing the nature of its visitor experience will help us plan for future modifications.

The Field Museum asked Selinda Research Associates (SRA) to plan, set up, and conduct such a final summative/remedial evaluation. We collected data from November 1999 through June 2000 using a naturalistic methodology and qualitative methods. A qualitative approach to visitor research is particularly useful in institutions that have different types of visitors with varying degrees of knowledge, experiences, and interest. Unlike quantitative methodologies, which look for an "average" experience, naturalistic inquiry aims to describe the range of visitor experiences and understanding. As such, it is a powerful tool for museums, especially those institutions concerned with reaching multiple audiences.

We conducted depth observations, unobtrusive observations, depth interviews, and an exhibition discussion group. We had a total of 133 respondents in 44 visitor groups. Because we purposively selected our respondents to elicit the widest ranges of responses as possible, percentages are not used in results.

Key Findings

Enjoyment

Visitors, especially families with children, we interviewed overwhelmingly enjoyed *Underground Adventure*. However, based on our observations and interviews, the exhibition did not work as well families with children five and under because their children were often too frightened by the Underground Experience and tended to have difficulty seeing objects in some areas. Congestion and noise from visiting school groups also lessened the enjoyment of the exhibition for a few adults and family groups we observed.

Learning

Based on a six-level knowledge hierarchy we developed for the exhibition (see the report for a complete description), virtually all of our respondents achieved Level One or Two on the hierarchy after visiting *Underground Adventure*. We had difficulty finding anyone still at Level Zero. The exhibition seemed to move some respondents to Level Three. Those who had already been at Level Four or Five were

reminded of their understandings by their visit, but the visits did not seem to move our respondents to these levels.

Messages

Many of our respondents perceived two of the four main messages of the exhibition. Fewer respondents took away messages about living things' connection to the earth's life support system and human interconnections with it. The biggest message missed by our respondents was that the soil portrayed in the Underground Experience was prairie soil. Some respondents indicated that they expected to receive more information about composting and recycling as well as the opportunity to touch real soil.

Engagement

Underground Adventure engaged visitors that we interviewed and observed in physical, social, intellectual, and emotional ways. Physical and emotional engagement was strongest and most varied in the Underground Experience area. Social engagement took place throughout the exhibition, but many families we observed had difficulty completing teaching-learning exchanges about the content with their children using the labels. Intellectual engagement was evident in the Mud Room, Connections, and the Quotes section of the Conclusions area.

Personal Connections

Respondents in our study expressed six primary ways they connected to the exhibition on a personal level. The most common ways were experientially or as a form of entertainment. Children, especially those aged five and under, often connected to the exhibition through fear. Some respondents connected to the exhibition based on their previous knowledge and experience or as a transformative experience. A very few visitors considered the exhibition boring because they felt if was not aimed at them or did not meet their expectations.

Perceptions of the Intended Audience

Most respondents thought that the Underground experience was for children. Because of the reading skills needed in order to use the interactives in the Mud Room, this area was considered to be more for middle school students, high school students, and adults. Respondents overwhelmingly considered the Theater and the Conclusions area to be for adults.

The Experience for Families with Children Age Five and Under

We observed many small children ranging from infants to early elementary students in the Underground Adventure. The experience of children five and under tended to be less rich and educational than that of older children and adults because they were usually scared and could not see objects without help. Because family members always accompanied the small children we saw, their less-than-optimal experience negatively affected the experience of the entire family.

The report discusses our findings in detail. It also includes our recommendations for remedial changes based upon results from this study as well as instructional design principles and previous research in visitor studies.

Team Summary

Introduction

Underground Adventure opened at The Field Museum in March 1999. Covering 15,000 square feet, it has engaged families, individuals, and scholars from around the world and remains a major draw in the museum. Determining the extent to which the exhibition is achieving its original goals and assessing the nature of its visitor experience will help us plan for future modifications. The Field Museum asked Selinda Research Associates (SRA) to plan, set up, and conduct such a final summative/remedial evaluation.

Methodology and Methods

A naturalistic methodology was used for this study. Naturalistic methodology is grounded in the idea that the world is comprised of many mutually constructed realities, all of which are valid. It strives to develop as complete an understanding of as many different realities (in this case, visitors' experiences) as is feasible.

In this vein, we have used a number of different methods to assess the nature of visitors' experiences: depth observations, evaluation meetings, unobtrusive observations, depth interviews, an exhibition discussion group, and group debrief meetings. A qualitative approach to visitor research is particularly useful in museums because these institutions have visitors with varying degrees of knowledge, experiences, and interests. Unlike quantitative methodologies, which look for an "average" experience, naturalistic inquiry aims to describe the range of visitor experiences and understandings. As such, it is a powerful tool for museums, especially those institutions concerned with reaching multiple audiences.

To help ensure variety among respondents, we used purposive sampling methods in selecting respondents for this study (Lincoln & Guba, 1985). In purposive sampling, each respondent is chosen for certain characteristics. The goal is to talk with respondents who are as different from each other as possible in order to elicit the widest range of responses as possible. Because purposive sampling deliberately selects respondents (i.e. the sample is not randomly generated), percentages are not used in results.

Data for this study were collected from November 1999 through June 2000. There were 133 respondents in 44 groups; we spent approximately 35 contact hours with respondents. Please see the full

report for a description of each method as well as a breakdown of the respondents and contact hours for each method of data collection.

Results

The following section highlights some of the major findings of this study. As this is only an overview, we refer the reader to the full report for a detailed discussion of the results. In the full report, we include a discussion on the implications of our findings as well as recommendations.

Results and Analysis 1 – The Visitor Experience

From the start, the *Underground Adventure* exhibition development team has been interested in understanding the extent to which—and the ways in which—visitors experience this exhibition. The results section of this report is divided into three sections. The first addresses the visitor experience, describing what it is like to be a visitor in *Underground Adventure*; the second discusses each specific exhibition area; and the third discusses five exhibit units within the Underground Experience area.

The visitor experience section covers the ways in which visitors enjoy the exhibition, how much time they spent in it, what they learned, the messages they took away, the ways in which they engaged with the exhibition, the ways they personally connected with the exhibition, and the experiences of families with children five and under.

Enjoyment

The feedback we heard from visitors was that they overwhelmingly enjoyed *Underground Adventure*.

Families with children, especially, felt that the exhibition was fun. However, although respondents who were part of families with children five and under considered the exhibition enjoyable, *Underground Adventure* did not work quite as well for this type of family as it could have. We found that fear was especially prevalent among children five and under and it usually affected them and their families' experience. In addition, these small children tended to have difficulty seeing objects in some areas.

Congestion and noise from visiting school groups (and other groups) also caused discontent for a few adult and small family groups that visited the exhibition during busy times.

Time in Exhibition

Based on tracking studies conducted during this study and by The Field Museum in a separate study, the average visit lasted between 25 and 26 minutes in the *Underground Adventure*—but the range between shortest and longest visits was quite large (under five minutes to more

than an hour). Based on our tracking study, respondents usually spent more time in the Underground Experience than in the Mud Room. However, respondents spent a wide range of time (from a less than a minute to about 30 minutes) in both areas. The Conclusions area had less of a range of times, with the average visit lasting about a minute.

Learning

We developed a six-level knowledge hierarchy for *Underground Adventure* to describe the range of understandings visitors have within the context of the exhibit.

Level Zero on the knowledge hierarchy represented no knowledge about or interest in the topic of dirt and soil. When we interviewed visitors for the summative/remedial evaluation as they left the exhibition, we had a difficult time finding anyone at Level Zero.

Level One on the knowledge hierarchy represented limited knowledge in the topic, but an interest in finding out more. Virtually all visitors we spoke with, except those under five years old, achieved at least a Level One understanding of the exhibition.

Level Two visitors we interviewed indicated a preliminary understanding of soil and dirt, but their understanding tended to be superficial and incomplete. The exhibit appeared to be successful at instilling in these visitors a new understanding of (and appreciation for) the fact that there are a lot of living things—a lot of *different types* of living things—in soil. We found this to be true with people who did not have very much experience with dirt and soil, and this level appeared to be very appropriate for children.

Level Three encompassed a basic understanding of the third main idea of the exhibition: that all the things underground are interrelated and interconnected. The exhibition seemed to move some respondents to this level.

A Level Four understanding of the exhibition included a realization of and appreciation for the fact that human beings are part of the equation. A few respondents articulated this level of understanding, but the majority of these people appeared to have been at this level before entering *Underground Adventure*. The exhibit may have reminded these respondents of their existing knowledge or helped them articulate their understanding.

A Level Five understanding indicated a more sophisticated understanding of the interrelationship between soil, humans, and the health of the planet. This level of knowledge was even less common among respondents than Level Four, and the small number of

respondents at Level Five seemed to have reached it before visiting the exhibition. The exhibition may have reinforced this position on the knowledge hierarchy, but did not seem to move people to Level Five.

Messages

We examined the messages that respondents took away from the exhibition in order to better understand the visitor experience and assess what people learned from *Underground Adventure*. By understanding the messages perceived (or not) by visitors, we also identified areas for improvement within the exhibition.

Perceived Messages

Many respondents picked up the first two main messages of the exhibition (that many things live underground and that they are connected to one another). Fewer respondents took away the intended messages about living things' connection to the earth's life support system and human interconnections with it. Unlike the other two messages, which visitors seemed to perceive in many different places in the exhibition, visitors we spoke with cited three specific places as bringing together the interconnection messages: the Advance Organizers, the Teaspoon of Soil, and the Conclusion quotes.

Missed Messages

Missed messages were those that the most respondents did not perceive, despite the intent of the exhibit team. The biggest message "missed" by most of our respondents was that the soil portrayed in the Underground Experience was prairie soil.

Expected Messages

Expected messages were those that our respondents expected to receive, but did not perceive, in *Underground Adventure*. Common messages that some respondents said they expected but did not get involved the touching of soil, composting, and recycling.

Engagement

In this study, in addition to the learning outcomes and messages, we examined four types of visitor engagement: physical, social, intellectual, and emotional. When all four types of engagement work in concert, the potential for learning is maximized.

Physical Engagement

Physical engagement is defined as all ways in which visitors interact with an exhibition's physical space, objects, and exhibit units. From our observations, we found a wide range of physical interactions throughout the exhibition, including reading labels, standing and looking, touching and climbing, pushing buttons, and even simply sitting and relaxing. Not surprisingly, we found that for most visitors, the physical engagement in the Underground Experience was richer and more varied than in the Mud Room, which featured a smaller range of physical activities (probably because it is a more conventional

space with counters, chairs, and computer monitors). In the Connections area and Theatre, most visitors we observed used the spaces as intended. Most of our respondents spent very little time in the Conclusions area, and those that did tended to spend most of their time standing and watching the Quadroscope.

Social Engagement

In this study, we examined three ways visitors tended to engage with each other socially: 1) sharing personal experiences and memories, 2) sharing surprising knowledge and revelations, and 3) developing deeper understandings. In our observations of and discussions with respondents for this study, we saw evidence of all three types of social interactions in all areas of the exhibition. When sharing personal experiences, most visitors tended to talk with each other about animals they had seen previously in other settings. A few talked with each other about gardening and/or spiritual experiences they had. Some visitors in the Underground Experience explained why they did not like a particular animal or recounted a story about why they were afraid. However, we did not encounter many statements of surprise or revelation.

The third type of social engagement we looked at—developing deeper understandings—includes a range of teaching-learning interactions, such as directing someone's attention to something, explaining a phenomenon or concept, asking/answering a question, reinforcing a concept, discussing an idea, relating content in one exhibit to ideas in another, group problem-solving, and reading/interpreting a label aloud. While most groups we observed tried to engage in many of these behaviors, many of them had difficulty carrying the teaching-learning exchange through to completion. Often, when an adult caregiver read a label to a child, this interaction was not followed by any further discussion. A few adult-older teenager and adult-adult groups were more successful at using the label as a jumping-off point for further exploration. It appeared that on the whole, most adults needed some direction to effectively engage their children in developing deeper understandings of the content of the exhibition.

Intellectual Engagement

The third type of engagement we examined was intellectual (defined as how visitors think about the content of an exhibition). This includes thoughtful behavior, reflection, and analysis—mulling over what is experienced and relating it to the visitor's own life—as well as scientific inquiry skills.

The nature of the intellectual activities varied for respondents depending on the part of the exhibition they experienced. In the Underground Experience, most of the intellectual engagement we

observed was limited to identification of species. The Mud Room, on the other hand, was a more cognitive experience that elicited a wider range of intellectual interactions. In the Connections area, a few of the relatively small number of visitors who used this area spent time relating what they saw to their own lives or entered into thoughtful discussions with their companions. In the Conclusions area, the quotes appeared intellectually stimulating for those who read them. Meanwhile, the Quadroscope was also intellectually engaging to some.

Emotional Engagement

The final type of engagement we examined was emotional engagement, which includes all the ways in which and the extent to which visitors experience the exhibition in an emotional way. It involves the ways and extent to which visitors experience emotions such as fear, awe, fascination, mystery, or skepticism.

The strongest emotional engagement we observed in the exhibition was in the Underground Experience. Respondents indicated a wide range of emotional experiences, from fear to playfulness and enjoyment. In contrast, the Mud Room elicited a narrower range of emotional interactions in virtually all observed visitors. The Theatre appeared to elicit some fairly strong emotions, including both enjoyment and disgust. In addition, a few respondents expressed a strong emotional engagement with the Conclusions area of the exhibition.

Personal Connections

We have found from previous studies that while visitors' experiences tend to be multi-faceted, rich, and complex, any *particular* visitor tends to form a primary way of thinking about and engaging with the exhibition and its content and objects. Visitors tend to develop a certain perspective or framework from which they experience and remember their visit. While the museum may be thinking primarily of the exhibition as an environment within which the visitor can develop a greater understanding of and appreciation for the exhibit content, visitors often develop a very different primary connection. In this study, we identified six primary ways that visitors appeared to think about and connect with *Underground Adventure*: experientially, in fear, as entertainment, relating to previous experiences, as transformative, and as boring.

Experiential, visceral, tactile

A common connection to the exhibition that appeared among our respondents was an experiential one (i.e. they often talked about the look, sound, and feel of the exhibition). Respondents who connected to the exhibition on an experiential level tended to focus on the Underground Experience and did not talk much about the Mud

Room or other areas. Not surprisingly, many of the respondents with experiential connections were children.

Fear

Another common way respondents appeared to connect to the exhibit was through fear. The need to deal with children's fears certainly reduced the effectiveness of the Underground Experience for almost all families with children five years old or younger. It seemed that success exacted a cost; the effective components of the Underground Experience were also frightening, especially to this age group. Respondents over five years old sometimes talked about "good fear"—they admitted being afraid, but they said they liked it. This scary, but fun, feeling was most apparent in elementary/preteen respondents.

Entertainment

A third common connection to the exhibition was to regard it as a form of entertainment. Respondent who connected to it most strongly in this way often described it as fun, or "Disney-like," and enjoyed the make-believe, fantasy aspects of the Underground Experience. Like the people whose connection was experiential, these respondents tended to talk about the Underground Experience area the most.

Personal previous knowledge and experience

Another primary connection to the exhibition among our respondents was based upon their previous knowledge and experience. Often these types of respondents connected the exhibit to their gardening hobby or to their spiritual beliefs.

Transformative

A few respondents discussed how the exhibition changed the way they think or would affect their future behavior. These respondents connected to the exhibition as a transformative experience. Gardeners among our respondents especially said the *Underground Adventure* created the urge in them to interact with soil. A few said the exhibition changed the way they thought about soil or even how they perceived The Field Museum.

Boring

A very few of the visitors we interviewed seemed to mainly describe the exhibit as boring because they felt that the exhibition was not aimed at them or did not meet their expectations.

Respondents' Perceptions of the Exhibition's Intended Audience

When asked "Who do you think the developer had in mind when creating the exhibition?" many respondents responded by splitting *Underground Adventure* into sections, each of which had a different audience. Most respondents thought that the Underground Experience was for "kids" (elementary students to preschoolers). This perception seemed to be due to both the "fantastic" atmosphere as

well as the tactile nature of many of the exhibits. Because of the reading skills needed to use the interactives in the Mud Room, this area was considered more for middle school students, high school students, and adults. Respondents overwhelmingly considered the Theatre and the Conclusions area to be for adults.

The Experience for Families with Children Age Five and Under

We observed many small children (children ranging from infants to early elementary students) in *Underground Adventure*, but their experiences tended to be less rich and educational than those of older children and adults. Furthermore, because children aged five and under were always accompanied by family members, their less-than-optimal experience also affected the experience of the entire family. In addition to the negative effects of children's fear, the problems with the experience of young visitors and their families tended to be caused by either physical placement of some objects or the amount of labels and their advanced reading requirements.

Because the Mud Room interactives required a considerable amount of reading and were more conceptually complex than the Underground Experience exhibits, it is not surprising that the Mud Room was less successful than the Underground Experience for the five-year-old and younger children we saw.

Results and Analysis 2 – Areas of the Exhibition

While "Results and Analysis 1" details our findings about the exhibition from the visitors' perspective, "Results and Analysis 2" describes our findings about the exhibition from the museum perspective by addressing the seven distinct areas of the exhibition: Advance Organizer, Base Camp, the Underground Experience, the Mud Room, Connections, the Theatre, and Conclusions.

Advance Organizer

Most visitors we observed walked by the Advance Organizer (the row of Plexiglas exhibit cases at the entry to the exhibition) without stopping. We observed visitors approaching the exhibition in such a way that they saw only the rear of the exhibit cases. During our data collection, we also saw a uniformed attendant directing groups up the ramp and away from the Advance Organizer.

In some situations, we observed visitors who did stop at the cases. They engaged in meaningful social interactions, pointing things out to each other and talking about things that they had not really thought came from the soil. When we talked with visitors who had stopped at the Advance Organizer, it appeared that they had a fuller appreciation of soil's role in our lives.

Base Camp

The base camp was an effective holding area. However, it was not as effective at setting up the experience as a whole. The visitors we observed generally did not slow down until reaching the Shrink Chamber, which seemed to work well.

Underground Experience

The Underground Experience effectively gave most respondents a feeling for being underground, but worked less well as a learning environment. Nonetheless, the sequence of the Underground Experience before the Mud Room was successful. Visitors we observed seemed to enjoy and respond to having concepts introduced in the fun, cool environment before the more structured learning environment of the Mud Room. Eight components of the Underground Experience are discussed separately below.

Shrinking

The Shrink Chamber and shrinking area worked well and set up the shrinking fantasy for both adults and children. Everyone we observed or interviewed indicated that they understood that they are supposed to have shrunk, but that they knew they did not. In contrast, the "un-shrinking" experience was insufficient.

Soil Environment

The Underground Experience was very effective at helping visitors we observed and interviewed realize that they were visiting the soil.

Soil Life

The Underground Experience was also very effective at helping our respondents realize they were seeing soil animals portrayed at much larger than life size. Perhaps the exhibit was too successful at portraying soil animals, since animals dominated many respondents' discussions of the exhibit. Because many of the viewing holes, cases, videos, and interactives were placed above preschoolers' heads, the Underground Experience was less effective for families with children five and younger.

Prairie Soil

The exhibition was not effective at informing our respondents that they were exploring prairie soil. Because most visitors we spoke with probably did not think to ask, "Where are we?" as they entered, the video and label interpretation about prairies did not sink in. Once they were deep inside the soil, a few began to wonder where they were, but at that point they could not find enough clues to answer the question.

Laboratory Fantasy

The part of the fantasy where visitors are supposed to visit a micro soil laboratory was ineffective for the visitors with whom we spoke. Perhaps the concept of a micro soil laboratory is too challenging for

visitors and is not reinforced by depictions of scientists in the exhibition.

Disney-esque

We were not surprised that many respondents compared their experiences to the movie *Honey, I Shrunk the Kids* or to immersion experiences at Disneyland, Disney World, or other commercial entertainment environments. These earlier experiences helped prepare these visitors for the Underground Experience, so most were not startled at the sight of giant animated bugs and had some idea of how to behave in an immersion experience. Although some respondents seemed to expect stronger Disney-like stimulations and expressed disappointment when they did not experience them, most (except those children who did not like being scared) seemed comfortable with an exhibit that engaged their senses without overwhelming them.

Educational Effectiveness

Overall, the Underground Experience tended to be most successful at creating an environment and a feeling of what it would be like to be able to go underground. Most of our respondents appeared to develop a deep appreciation for all the organisms that live underground and repeatedly demonstrated that they enjoyed the immersion experience. The Underground Experience appeared less successful at conveying all the important content messages, possibly because the content/educational messages compete with the immersion experience.

The Underground Experience was very effective at helping most of our respondents discover that many different kinds of animals live in the soil (Level Two in the learning hierarchy). In the front-end study, most respondents seemed to be at Level Zero or One, so this basic understanding about soil life may represent a jump of one or two levels. A lesser number of visitors we talked to seemed to approach Level Three. These visitors learned about a few of the simple interrelationships in the soil, such as bugs eating fungus and spiders eating grubs. However, we found that very few respondents could indicate a solid Level Three "all the stuff is interrelated" understanding. A still smaller number of respondents were reminded of their existing Level Four and Five understandings. Although we found no evidence that Underground Experience in itself raised these respondents to a Level Four or Five understanding, those who already had achieved these levels found ample opportunity to recall their existing knowledge and, in some cases, talk about it with their companions. In the front-end study, it seemed that most respondents did not think about soil much, so stimulating recollections may also be considered a measure of the effectiveness of the exhibit.

Layout and Orientation

Based upon our observations and interviews, the layout and orientation of the exhibition appeared to work well.

Mud Room

The Mud Room appeared to be effective for the older children and adults we observed and interviewed, but did not appear to be effective for families with children who could not read. Because it is a more conventional museum atmosphere with a variety of interactives, the Mud Room required a fair amount of reading to understand the content. In addition, a few visitors we saw who noticed the name of the room appeared to be misled it since they expected the room to contain mud.

The Mud Room was effective at creating a different look and feel than the preceding Underground Experience. The majority of our respondents seemed to perceive that the Mud Room focused more on learning and education. Three components of the Mud Room are discussed below.

Perception of Size

There were indications that the Mud Room helped some respondents think about the true size of the creatures they had seen in the Underground Experience.

Conservation Messages

The Mud Room seemed to be only partially effective at communicating messages about soil conservation. The few respondents who did talk about soil conservation often cited the quotes in the Conclusions area, the Connections area, and various things they had seen in the Underground Experience.

Scientist Messages

The Mud Room did not seem to communicate effectively how scientists study soil. Although we watched a few parents talk about scientists while guiding their kids through various interactives, none of our respondents seemed to notice that "this is how scientists really study soil" was a major part of the message.

Connections

While some respondents really liked the Connections area, most ignored it or used it as a resting place. The respondents who liked it found that it helped contribute to the overall "interrelationships" message of the exhibition.

Theatre

For the most part, the Theatre did not work particularly well for the respondents we observed and talked with. The format of the films frustrated some respondents, and the content offended at least one person. However, it was difficult to assess visitors' overall reaction to

the Soil Theatre, because (like other elements in the Connections area) it was often not visited.

Conclusions

Many visitors we observed stopped to look at the Quadroscope in the Conclusions area; it was attractive and had an emotional impact. However, some seemed to have trouble integrating the Quadroscope with the rest of their soil experience. While the Quadroscope may have seemed new and interesting, it did not serve as an effective conclusion to Underground Adventure for many respondents.

Those few visitors we observed who read the Quotes often found them meaningful and cited them as take-home messages for the whole exhibition. On the other hand, the Quotes also reminded a few respondents of expected—and even hoped-for—conservation messages that they had not seen in the rest of the exhibit, which left them somewhat disappointed with their experience.

Results and Analysis 3 – Exhibit Units

In the third Results and Analysis section, we address five specific units in the Underground Exhibit particularly important to the visitor experience: the Penny and Rulers, the Teaspoon of Soil, the Movement Video, the Mole Tracking Station, and the Cicadas. With the exception of the Mole Tracking Station, which few visitors used or understood, these exhibit units in the Underground Experience successfully engaged the visitors in physical, social, intellectual, or emotional ways.

Penny and Rulers

Both the Penny and Rulers exhibits were effective, giving the visitors we observed two different ways to think about and react to their "shrunken" sizes.

The Penny seemed to give our respondents a gut-level feel for their size, helped establish a somewhat whimsical tone for their adventure underground, and initiated social interactions between group members.

Using the shrink check station to get a more exact measure of their new size was often a group activity, with adults and children comparing their respective measurements. This very simple interactive seemed to have a lasting effect. Many groups we observed also stopped later at the ruler near the Underground Experience's exit, measured themselves again, and remarked on the difference.

Teaspoon of Soil

The visitors we observed and talked to seemed impressed, and perhaps even mildly disgusted, with the Teaspoon of Soil. Although

most visitors appeared to enjoy the exhibit and get a lot out of it, the flashing lights confused some visitors.

Many of our respondents walked out of the exhibit thinking about the large number of creatures in the soil. The Teaspoon of Soil and associated labels seemed to effectively establish that message.

Movement Video

The videos seemed to give visitors we observed a feel for how soil animals really move, conveying the information quickly and wordlessly in a fun, lighthearted way.

The effectiveness of the videos was diminished somewhat because they were placed too high for children who were five and under to operate or see easily and were surrounded by other distractions. Nevertheless, the videos and accompanying music often became triggers for social interaction. We observed disbursed groups reassembling to enjoy and discuss them.

Mole Tracking Station

We observed very few visitors using this exhibit, perhaps because of the competition from nearby giant bugs and the Movement Video. When we did observe visitors using the unit, they had a difficult time figuring out what to do and what they were supposed to take from the experience. In addition, many respondents indicated confusion between the model of the mole cricket and the mole tracking station.

Cicadas

For most visitors we observed, especially children or those accompanying children, the Cicadas appeared to work well. Designed mainly as a photo opportunity for visitors, the Cicadas served this function well. Though conversations in this room were not particularly meaningful because the labels explaining the exoskeletons were outside the room, this was a good play area for some of the younger children.

Introduction

Overview

Underground Adventure opened at the Field Museum in March 1999. Covering 15,000 square feet, it has engaged families, individuals, and scholars from around the world, and continues to be a major draw in the museum. Throughout the exhibition development process, the museum has demonstrated a strong commitment to evaluation, incorporating front-end and formative evaluation findings in design and development. From the beginning of this development project, funds have been set aside to modify the exhibition after it is determined the extent to which the exhibition is achieving its original goals and objectives and the nature of the visitor experience can be assessed. Now that the exhibition has been open for more than a year, the Field Museum is interested in conducting a final summative/remedial evaluation. Selinda Research Associates (SRA) was asked to plan, set up, and conduct such a study.

Research Questions

1. To what extent, and in what ways, does *Underground Adventure* achieve its goals and objectives?

2. What is the nature of visitors' experiences in *Underground Adventure*?

3. What can we discover about visitors' experiences in this exhibition that will help the development team revise it?

Description of the Exhibition

Underground Adventure is a 15,000-square foot exhibition that requires an additional ticket for entry. At the time of this report, tickets cost $6 per adult and $4 per child and can be purchased either when entering the museum or at the exhibition itself. The exhibition is free for museum members.

For the purposes of this study, the exhibition is comprised of seven distinct areas:

a. the Advance Organizer area, which includes the title to the exhibition, a series of cases containing objects from the soil, and a long ramp/hallway leading to the ticket desk;
b. Base Camp, which includes a ticket desk, some video monitors, an introductory area setting the stage for what visitors will see and experience, and a Shrink Chamber which simulates the visitor

shrinking to 1/100th of their actual size;
c. the Underground Experience, a simulated underground immersion environment where visitors walk among soil particles and see giant robotic bugs and other critters, roots, and seeds, and exit via a brief Reverse Shrink Chamber;
d. the Mud Room, a large, brightly-lit area housing many hands-on interactives, exhibit units, several computers, and a few natural history specimens;
e. the Connections area, which includes a large bench, numerous artifacts, and wall-mounted display cases depicting the human connection to soil;
f. the Theatre, which continuously displays abbreviated film clips of movies about soil produced locally as part of a museum-sponsored, national-wide competition; and
g. Conclusions, a large open room with a recessed video projection of Planet Earth (Quadroscope) along one wall and quotations concerning soil screened on an opposite wall.

Each of the seven exhibit areas has numerous exhibit units. A detailed listing of all exhibit units and the names used in this study is included in Appendix A: List of Exhibit Names.

At the time this study was conducted, visitors passed a gift shop, which is not part of this study, after leaving the Conclusions area. The gift shop has since been closed.

Goals and Objectives of Exhibition

The goal of the *Underground Adventure* is to communicate four main messages to visitors:

1. Many things live underground.

2. These living things are connected.

3. These living things are vital to the earth's life support systems.

4. Humans are an important part of these interconnections.

Each area of the exhibition has specific objectives related to these four messages:

a. The Advance Organizer area introduces the subject of soil, piques the interest of visitors, and focuses on the fourth message concerning humans' interconnections.
b. Base Camp prepares visitors to experience the fantasy of being

underground.

c. The Underground Experience encourages exploration through physical immersion in the content. It reinforces the first message— that many things live underground— and gives specific examples of message two by showing connections between organisms that eat one another.
d. The Mud Room cognitively stimulates visitors through interactive experiences with the content. It emphasizes that living things are connected (message two) and are vital to the earth's life support systems (message three).
e. The Connections area highlights the fourth message about interconnections and is an interlude where visitors can make connections between the content and their own lives.
f. The Theater also conveys the message that humans are connected to the soil by helping people think about their own connections to soil through seeing and experiencing how other people feel connected to soil.
g. Conclusions is a place for visitors to reflect upon the importance on soil in a relaxing, meditative manner. This area addresses messages two, three, and four.

Definitions

The terms "soil" and "dirt" are used somewhat interchangeably in this report. We use the term "soil" to refer to all the organic and inorganic materials that comprise soil, including rocks, roots, seeds, microbes, insects and other animals that live underground. We use the term "dirt" as visitors indicated they used it: to refer to the dry, crumbly stuff that is one part of soil.

Language

Selinda Research Associates is committed to non-sexist language that recognizes the differences between the sexes, but treats both sexes equally and fairly. We believe this language more accurately reflects reality because it avoids false assumptions about the nature and roles of women and men in society. In this report, we followed the American Psychological Association's "Guidelines to Reduce Bias in Language" (1994).

The Researchers

As with any research, the results of this study are dependent in part on the people who worked on the project. Prior to the *Underground Adventure* summative evaluation, Selinda Research conducted both the front-end and formative evaluations for this exhibit. Six Selinda associates participated in the current summative/remedial evaluation.

Deborah L. Perry, Ph.D., project manager for this study, has been Director of Selinda Research Associates since 1989. With a Ph.D. in Instructional Systems Technology, she has conducted research on the role of intrinsic motivation in informal educational settings focusing on the question "What makes learning fun?" Deborah has extensive experience in museum exhibit and program evaluation and development and has consulted with museums and other organizations throughout the United States, Canada, and in the United Kingdom. She specializes in naturalistic inquiry and uses a variety of qualitative and quantitative data collection strategies, including focus groups, interviews, observations, and written surveys. Deborah has worked with the Field Museum on a number of projects including the front-end and formative evaluation of the *Underground Adventure*.

Data collectors for this project were Cecilia Garibay, Lynette De Johnette, and Leslie Rebecca Bloom. Cecilia has an extensive background in museums and ten years' experience in market research for non-profits, corporations, and foundations. A native of Mexico City, Cecilia has a special interest in evaluating exhibits and programs serving minority and multicultural audiences. Currently working on her Master's degree in psychology, Cecilia has worked as a museum consultant with Selinda Research Associates since 1994 and participated in the front-end and formative evaluation of the *Underground Adventure*. Other Field Museum projects she has worked on since 1995 include the *Chocolate* front-end and formative evaluations, the *Audience Research Initiative*, the *SUE* front-end evaluation, the *SUE Un-crated* evaluation, and the *New Explorers/Mystery of the Andes* video.

Lynette De Johnette has worked in visitor studies since 1994. Lynette has previously served as Audience Research Manager on projects for the Wildlife Conservation Society in New York, conducting qualitative and quantitative evaluation. She has also conducted visitor research at the Shedd Aquarium, the Field Museum, the Brookfield Zoo, and the Adler Planetarium. Lynette holds a B.A. in Economics with minors in African-American history and marketing. She is currently pursuing her Master's degree in Economics. Lynette has worked with Selinda Research Associates since 1999 and at the Field Museum on the

Chocolate front-end and formative evaluations. In addition to her data collection duties on this study, she also was a respondent in a depth observation.

Leslie Rebecca Bloom, Ph.D., is an Associate Professor of Education at Iowa State University and specializes in qualitative research methodologies. In addition to her teaching and research, she has conducted several evaluation studies for university programs and frequently gives talks and workshops on qualitative research and evaluation. Leslie's recent qualitative study focuses on welfare-to-work education programs. During the *Underground Adventure* study, Leslie was also a respondent in a depth observation.

Eric D. Gyllenhaal, Ph.D., and Jane Schaefer were writers and data analysts for this report. Eric has more than twenty years experience in the museum field, including work as an exhibit developer and evaluator at the Field Museum. Eric was an exhibit developer during the early stages of *Underground Adventure* and co-wrote a report on the front-end studies. Eric's educational background includes a B.S. in Geology and a Ph.D. in Paleontology and Stratigraphy, and he has conducted field research on both modern and ancient soils. Since *Underground Adventure* opened, Eric has visited often with his two young boys, and he and members of his family were respondents in a depth observation for this study.

In addition to her experience as a writer, Jane Schaefer recently completed a Master's in Design specializing in human-centered communication design. Jane is especially interested in naturalistic inquiry and has completed design projects with the Chicago Symphony Orchestra, the Chicago Public Schools, and Planned Parenthood. The *Underground Adventure* summative/remedial evaluation, in which she also participated as a depth observation respondent, is her first project with the Field Museum.

Limitations of the Study

This study had limitations in the types of visitors studied and the nature of their experiences. Researchers focused their observations and interviews on family and adult visitor groups. Because the evaluation team decided to concentrate on experiences of casual visitors, we did not observe or interview school groups or teachers.

One question that emerged as we studied the *Underground Adventure* was "What was the experience like for visitors with disabilities?" Although we had hoped to have the ability to explore this question, and did have the opportunity to observe one visitor who used a

wheelchair, resources did not allow us to pursue this question in depth with more wheelchair users or with people who have visual or auditory disabilities. Since we have every reason to believe that visitors with disabilities would have much different experiences in the *Underground Adventure* than our respondents because of the physical configuration of the space, we highly encourage the Field Museum to explore this issue in detail.

While this study covers some observed behavior at the Mud Room computer stations, it does not include an in-depth analysis of visitors' experiences with the computer software. The Field Museum is conducting a separate study that will address the interactions visitors have with the computer interfaces.

Methodology and Methods

Overview

"A research *method* is a technique for (or way of proceeding in) gathering evidence….A *methodology* is a theory and analysis of how research does or should proceed." p. 2 (Harding, 1987)

A naturalistic methodology was used for this study. While many researchers use the terms "methodology" and "method" interchangeably, in this study we will use them quite differently. Naturalistic methodology is grounded in a set of beliefs, including the idea that the world is comprised of many mutually constructed realities, all of which are valid. In other words, the goal of naturalistic inquiry is not to determine an ultimate objective reality so that one can make predictions about future events (in this case, visitors' behavior and learning). Rather, it strives to develop as complete an understanding of as many different realities (in this case, visitors' experiences) as is feasible.

In this vein, we have used a number of different qualitative methods to assess the nature of visitors' experiences. These methods are described in detail below. A qualitative approach to visitor research is particularly useful in museums because these institutions have different types of visitors with varying degrees of knowledge, experiences, and interests. Unlike quantitative methodologies, which look for an "average" experience, naturalistic inquiry aims to describe the range of visitor experiences and understandings. As such, it is a powerful tool for museums, especially those institutions concerned with reaching multiple audiences.

To help ensure variety among respondents, we used purposive sampling methods in selecting respondents for this study (Lincoln & Guba, 1985). In purposive sampling, each respondent is chosen for certain characteristics. The goal is to talk with respondents who are as different from each other as possible in order to elicit the widest range of responses as possible. Because purposive sampling deliberately selects respondents (i.e. the sample is not randomly generated), percentages are not used in results.

Data for this study were collected from November 1999 through June 2000. There were a total of 133 respondents in 44 groups; we spent approximately 35 contact hours with respondents. These figures do not include talking with the developers in the evaluation meetings described below.

Depth Observations

"It has always been recognized that building and maintaining trust is an important task for the field inquirer….The development of trust…is something to which the naturalistic inquirer must attend from the very inception of the inquiry." p. 258 (Lincoln & Guba, 1985)

In this study, we implemented a technique we called the depth observation (to distinguish it from the depth *interview*, which will be described later.) In a sense, the depth observation is a combination of the more well known depth interview and participant observation. It involves selecting specific respondents already known to the interviewer and with whom we have already established a high level of trust. In this case, respondents included four SRA associates and their children as well as friends and relatives of the evaluators. A summary and brief description of all the depth observation respondents is included in Appendix B: Overview of Depth Observation Respondents.

Although this technique is rarely used in museum exhibition evaluation, we felt it held promise because it is essential to naturalistic inquiry to develop a trusting relationship with the respondent. As all museum evaluators can attest, it is difficult to establish the level of trust necessary when recruiting casual visitors to the museum as respondents. Although they are often willing participants in the study, there is limited time to establish trust. Most respondents we have worked with give freely of their opinions, but there almost always remains a certain element of holding back, or wanting to give the "right" answer. This is an expected and natural occurrence in field research. Lincoln and Guba (1985) suggest "the selective use of informants" as one way of dealing with this issue.

Each depth observation consisted of meeting the respondents at the museum and giving them a brief overview/orientation to the process. Their role was explained as that of a visitor, even though some of the respondents were museum professionals. They were encouraged to behave as they would if they were going through the exhibition on their own and were not part of the evaluation, although they were also encouraged to "think out loud" whenever possible. The data collector participated in the visit to whatever extent felt natural and comfortable, but always let the respondents decide where to go, what to see, and how long to stay. During the entire visit, the data collector took detailed notes about where the respondents went, what they looked at and interacted with, places they became confused, comments they made, and conversations they had. The collector also noted the time spent in different areas of the exhibition.

After the group left the exhibition, a final interview was conducted. This often took place over lunch in the museum restaurant. When the interview was concluded, each respondent was given a small token of appreciation from the *Underground Adventure* gift shop. In addition,

respondents were provided with lunch and paid transportation (or parking).

After the depth observation was completed, and the respondents left, the evaluator wrote up a detailed debrief (a written summary and analysis of the data collection). It includes a description of the respondent group, a summary of the visitor experience, an explanation of why this respondent was selected, and an overview of important findings. It also includes a summary of total contact hours (or minutes) spent with the respondent, and a reflections section, where the evaluator reflects on the data collection and makes recommendations for future data collection. See Appendix C: Debrief Example for an example of a written debrief.

We conducted a total of eight depth observations with 15 respondents. All respondents were selected because we felt they would be thoughtful and articulate about their experience in the gallery, and because we believed they would bring a unique perspective to the evaluation study. We spent approximately 13½ contact hours with depth observation respondents.

Evaluation Meetings

Although team meetings are not often considered data sources for evaluation projects, they played an important role in this study. One tenet of naturalistic inquiry is that data must be collected from as many different sources as possible. Because we felt it was important to find out the extent to which the exhibition development team felt *Underground Adventure* achieved its objectives and where it fell short of its original intentions, we chose to talk with the developers to get their input. We also used these evaluation meetings to revisit and refine the original goals and objectives.

A total of eight evaluation meetings were held from November 1999 through May 2000. All meetings included at least the lead evaluator from the evaluation team and the lead developer from the development team. Most meetings also included an additional exhibit developer, involved in developing the exhibition, and an administrative assistant. In addition, the museum's in-house evaluator, a museum summer intern, and two SRA data collectors attended a few of the meetings. In addition to the three evaluators, a total of six museum staff participated in the evaluation team meetings.

Evaluation meetings usually included a series of discussions covering the following topics: a) housekeeping issues; b) findings from the *Underground Adventure* tracking and timing study being conducted by

the museum; c) staff perceptions of the types of visitor experiences the various sections of the exhibition elicited, and where the exhibition was more successful (and less so) at achieving its stated goals and objectives; d) a review of selected issues on the topical framework; e) a summary of findings to date; and f) a review of issues to target for the next round of data collection. Meetings usually lasted from one to two hours for a total of approximately 11 hours. Detailed notes were taken during all meetings, and after most meetings, an evaluator wrote a summary.

Unobtrusive Observations

In addition to the eight depth observations, it was essential, in our view, to observe casual museum visitors in order to get a more rounded picture of the more naturally occurring visitor experience.

In conducting unobtrusive observations, we selected a respondent group when it crossed an imaginary line at the beginning of the Advance Organizer section of the exhibition. Respondents were followed as they progressed through the exhibition, and detailed notes taken about their observed behavior, apparent intellectual engagement, and social interactions to the extent possible (Perry, 1989). We recorded the time the group spent in each of the exhibition's nine sections, as well as the units group members visited and what they did at each unit. When the group split up, this was noted, and we took notes on as many members of the group as possible. When this was not possible, we followed one individual until the group re-convened. Visitors were observed until they left the Conclusions area, before they entered the gift shop.

When possible, respondents were approached as they left the exhibition and invited to participate in a depth interview. About half of the unobtrusive observations were followed by depth interviews. After data collection was completed, a detailed debrief (as described above) was written.

We observed a total of 97 respondents as part of 29 unobtrusive observations. Data were collected over a nine-week period from April through June 2000. See Appendix D: Observations and Interviews for a summary of unobtrusive observations conducted. The number of contact hours spent with unobtrusive observation respondents is included with the depth interviews in the following section.

Depth Interviews

Whenever possible, we followed up an unobtrusive observation with a depth interview. When the observation was completed, the visitor

group was approached and asked if they would be willing to participate in an interview. If the group members agreed, we took them to a quiet place in the exhibition, where we had set up a table, and conducted the interview with as many of the group members as possible. These interviews focused on eliciting accounts of visitor experiences in the gallery and clarifying many of the things we had observed when they were in the exhibition. The interviews were open-ended and relatively unstructured, although an interview protocol was used to guide the conversation and ensure that important topics were covered. When possible, we taped and later transcribed the interviews. After the completion of an interview, we gave each respondent a small token of appreciation from the *Underground Adventure* gift shop. Afterwards, the evaluator completed a detailed debrief, as described above.

Although we usually tried to precede a depth interview with an observation of the visitor group in the gallery, we found that this became time-consuming due to the size of *Underground Adventure*. Toward the end of data collection, we conducted six interviews with 16 respondents who we had not observed in the gallery. We selected these respondents as they exited the long hallway (after the gift shop) and asked them to participate in an interview.

We interviewed a total of 50 respondents in 18 groups. Total contact time spent with all 113 depth interview and unobtrusive observation respondents was approximately 19½ hours.

Exhibition Discussion Group

In an effort to gather different kinds of information based on trust, introspection, and in-depth discussion, we used a new data collection technique that we called an Exhibition Discussion Group. This technique uses a format similar to that of a book discussion group. All respondents were friends, relatives, and/or colleagues of the SRA evaluators, and respondents were selected to represent a range of viewpoints and backgrounds. After agreeing to participate, the respondents visited the exhibition at some time during the next two weeks, at their own leisure, and to experience it as they wanted. They then gathered at the offices of SRA for a discussion over pizza about the exhibition. One participant agreed to act as moderator, and came prepared with a few questions to guide the discussion. Three evaluators were also present to take notes and ask directed questions. The discussion group lasted approximately two hours. When it was concluded, the respondents were thanked and given small tokens of appreciation from the *Underground Adventure* gift shop. Participating in

the discussion group, in addition to the three evaluators, were five respondents.

Group Debrief Meetings

During this study, the evaluation team met five times for group debrief meetings. These were held from May through July 2000. During the group debrief meetings, emerging results of the data collection were shared and discussed. The initial meetings were relatively unstructured, beginning with a general discussion about findings to date. From the third meeting on, we structured discussions around the topical framework and the list of research questions included in Appendix E: Topical Framework and Appendix F: Research Questions, respectively, but remained open to any additional issues if they emerged. All group debrief meetings included a summary of how much data had been collected as well as a discussion of areas we wanted to target during the next round of data collection. Each meeting lasted about two hours, leading to approximately 10 hours total of group debriefing. Detailed notes were taken during all group debrief meetings; the final two were tape recorded and transcribed.

Data Citations

We used the following conventions in this report when citing our data:

The numerals of the citation indicate the group number of the respondents. Usually this number is based upon the date of the contact. The letter code following the dash indicates the form that the data took. "I" designates a quote from an interview transcript; "D" indicates one from a debriefing report. For example, a quotation marked [052201-I] comes from the interview transcript for group 052201, which was the first group interviewed on May 22, 2000.

Results and Analysis 1 – The Visitor Experience

Overview

Museums around the country are increasingly interested in the visitor experience. Two important works—*The Museum Experience* and *Learning from Museums: Visitor Experiences and the Making of Meaning*, both by John Falk and Lynn Dierking—have provided important insight into the richness and complexity of visitors' experiences in informal learning settings. From the start, the exhibition development team for *Underground Adventure* has been interested in understanding the extent to which—and the ways in which—visitors experience this exhibition. The results section of this report is divided into three major segments; the first takes a visitor perspective and describes what it is like to be a visitor to *Underground Adventure*. The other two are a discussion of specific exhibition areas and exhibit units. The discussion on the visitor experience will cover the ways in which visitors enjoy the exhibition, how much time they spent in it, what they learned and the messages they took away, the ways in which they engaged with the exhibition, and the ways they personally connected with the exhibition, as well as the experiences of families with children five and under.

Enjoyment

The feedback we heard was that our respondents overwhelmingly enjoyed *Underground Adventure*. Families with children, especially, felt that the exhibition was fun. However, although the families with children five and under who we talked to or observed considered the exhibition enjoyable, it did not work quite as well for them as it could have.

Overall, the visitors we interviewed indicated that they enjoyed their visit to the *Underground Adventure*:

> I liked it. I think it's very cultural and it has a lot of different hands-on parts where you can…look through a microscope and you can see things a little bit more close up, as far as maybe identifying different bug parts and stuff. I really liked it. [051803-I]

> My niece is three. And she liked it. And she's very—she's always very busy. So if she slows down to look at something, it obviously is very engaging and captivating. [061501-I]

> I was impressed by the first section with the soil. And it seems like you're going through underground tunnels that the bugs pass through. And being an artist, I was

> really impressed by the bugs and the worms and all that stuff. [061404-I]

Some adults appeared to perceive that the exhibition was primarily for children. For example, "A teenager rated it a six. The data collector asked him why, and he said he felt it was geared toward younger kids." [042602-D] Another visitor said:

> Well, I think when you look at a kid's mind, a kid's mind is very fascinated, especially with bugs and things that they can touch physically. I think a kid would be very interested in this. [052202-I]

The Underground Experience, sometimes compared by adults to a Disney attraction or the Rainforest Café, was the section most strongly perceived to be for children. An adult respondent said, "The part, I think…for kids was the animation…with, like, the insects and spiders." [052201-I]

The perception that the exhibition is for children may affect visitors' recommendations of *Underground Adventure*:

> I think this is good for children. I do. I mean, I do think it was geared towards children, or any kind of like teachers who are trying to get some points across, some science and things like that. I think it's good for them….if I was telling someone like somewhere to bring their children, if they were here, I would talk to them. [052201-I]

Ironically, our respondents who were families with children five years old and under tended to enjoy the exhibition *less*. There appeared to be two reasons for this.

We found that fear was especially prevalent among families with small children. For example, we observed one family (a mother, father and boy between four and six years old) that had the following experience:

> As they entered the mirrored shrinking stages, the boy held his father's hand and whined, "I don't want to go in there." The father let the boy's hand go and walked ahead. The boy stood back looking frightened. The father said, "Hurry! Run!" When he reached his father he grabbed his hand and held it tightly throughout the Underground Experience….The boy's fear set the tone for the group's experience. Although the father led the visit, it appeared to be based on the boy's reactions. If the boy kept moving, so did the parents. [051701-D]

As a result of the child's reaction, this family spent only five minutes

in the exhibition. A later section of this report describes the fear of respondents five and under in more detail.

The second reason that many families with small children did not enjoy the exhibition as much as other visitors was that five-year-olds and younger children had difficulty seeing objects in many areas. Some objects tended to be too high, and views were obstructed. With some notable exceptions, like the glass wall in front of the earwig and the holes in the floor near the crayfish, young children had a harder time finding their niche. Virtually all adults with children five and under were observed holding up (sometimes with difficulty) their children to see exhibits, and some even complained during interviews about this problem. For example:

> The respondent also mentioned that she got tired of having to lift him up to see so much of what was in the Underground Experience. I can see how this could get annoying to parents, especially if they have a couple of younger kids with them. [060301-D]

In a later section of this report, we discuss the experiences of families with children five and under in more detail, including their experiences in both the Underground Experience and the Mud Room.

Finally, we saw another source of discontent among adult and small family groups that visited the exhibition when school and other groups were there. The crowds, and kids, tended to be very disruptive, which made for a less-than-pleasant experience for the adult and family group visitors.

> There were too many kids and they were just running around. I would have spent more time in there looking at things. And I think I missed a corner or something and I didn't want to go back because they were just swamped with these children like everywhere, running. So I wish—I don't know, like maybe there could be a special thing for them or something. [052201-I]

> …it was fascinating about different kinds of insects in such a small area…I didn't spend a whole lot of time looking at—there was quite [a lot of] congestion over there, with the microscope area. [051803-I]

> The woman and boy continued to walk and came to the nursery, but again, there was a big crowd that seemed to deter them from going that way. [042601-D]

Time In Exhibition

Based upon tracking studies conducted during this study, and by The Field Museum in a separate study, the average visit lasted between 25 and 26 minutes in the *Underground Adventure*—but the range between shortest and longest visits was quite large. During our study, we also separated time spent in the Underground Experience from that spent in the Mud Room and found that our respondents tended to spend more time in the Underground Experience area.

Both SRA and the Field Museum conducted tracking studies to determine how long visitors were in *Underground Adventure*. The Field Museum tracked the total time spent in the exhibition of 100 randomly chosen visitors. During 29 unobtrusive observations, we tracked the time that our respondents spent within the entire exhibit and within the major areas. Despite the fact that our sample was purposive and, as a result, may not represent the audience as a whole, our data is consistent with the Field Museum's tracking data.

Total Time in Exhibition (in minutes)

	Field Museum data	*SRA data*
Mean	25.2	26.8
SD	12.3	14.7
Median	23.1	27.0
Min	2.5	4.5
Max	75.5	73.0

As the shown above, the shortest visits to the *Underground Adventure* (under five minutes in each case) were very short, while the longest visits lasted more than an hour.

For this summative/remedial evaluation, we also isolated times spent in the Underground Experience, Mud Room, and Conclusions areas in order to better understand visitor behavior in these areas.

Selinda Respondents' Time in Three Major Areas (in minutes)

	Underground Experience	*Mud Room*	*Conclusions*
Mean	15.0	11.9	1.0
SD	8.1	8.5	0.7
Median	13.0	10.0	1.0
Min	3.0	<1.0	0.0
Max	39.0	32.0	2.0

On average, respondents usually spent more time in the Underground Experience than in the Mud Room. However, a wide range of time (from a less than a minute to about a half an hour) was spent in both of these areas. The Conclusions area had less of a range of times, with the average visit lasting about a minute.

Learning

After months (or years) of hard work developing an educational experience for visitors, most museums are interested in whether or not they were successful. Did visitors get it? Did we teach them anything? Did we make a difference?

We repeatedly hear these familiar questions, and with good reason. Museums have educational missions and an obligation to provide quality teaching/learning opportunities. The problem, of course, arises when we try to measure how much actual learning takes place in a particular museum exhibition. As numerous researchers (Falk & Dierking, 2000; Perry & Spock, 1997) point out, the kinds of learning that take place in museums vary widely depending on a range of factors including the age of the visitor, the social group of which the visitor is a member, prior knowledge and previous interest in the topic (Doering & Pekarik, 2000), and the visitor's personal agenda. At the same time, museums have specific educational messages they hope to communicate.

A number of years ago, a technique was developed to assess learning at a museum exhibit (Perry, 1993b). Known as the knowledge hierarchy, the purpose of this technique is to describe the range of understandings visitors have within the context of the exhibit.

> The knowledge hierarchy assessment technique is based on the assumption that inherent in each exhibit is an internal knowledge structure. This knowledge structure is at the intersection of the exhibit developer's and the visitor's organization and understanding of the topic. A knowledge hierarchy is simply a description of this range of understandings. It is not the range of knowledge visitors have about a topic, but the range of knowledge within the context of the exhibit. p. 73 (Perry, 1993b)

At *Underground Adventure,* we identified a six-level knowledge hierarchy. Following is a description of each of the levels of visitor understanding.

Level 0

I don't know much about soil, and truthfully, I don't care much.

Level Zero on the knowledge hierarchy represented no knowledge about or interest in the topic—in this case dirt and soil. During the front-end evaluation, most visitors with whom we spoke indicated a

Level Zero in terms of interest in and knowledge about soil and what lives in it (Perry & Garibay, 1996; Perry, Garibay, & Gyllenhaal, 1998). On the other hand, when we interviewed visitors for the summative/remedial evaluation as they left the exhibition, we had a difficult time finding anyone at Level Zero.

Level 1

I don't know much about soil, but now I'm curious.

Level One on the knowledge hierarchy represented limited knowledge in the topic, but an interest in finding out more. Respondents at Level One indicated they did not know very much about soil, but were curious and had some questions.

Virtually all visitors we spoke with, except those who were under five years old, achieved at least a Level One understanding of the exhibition.

Level 2

Lots of stuff lives underground, but I don't know much about it.

Level Two visitors we interviewed indicated a preliminary understanding of soil and dirt, but their understanding tended to be superficial and incomplete. Usually it was characterized by comments like "Wow. There's a lot of stuff that lives underground!" For example, one Level Two respondent explained, "…I just think about dirt as kind of being there, but it's a living thing." [060701-I] When asked how he would sum up *Underground Adventure* for a friend, an eight-year-old visitor at Level Two of the hierarchy replied, "That different types of grubs live in different types of soil." [042602-I]

This level appeared to be very appropriate for children in particular. Furthermore, the exhibit appeared to be successful at instilling in these visitors a new understanding of, and appreciation for, the fact that it's not just dirt, perhaps with worms and ants, but that there are a lot of living things—a lot of *different kinds* of living things. We also found this to be true with people who did not have very much experience with dirt and soil.

Level 3

All that stuff that lives underground is interrelated in some way.

Level Three encompasses a basic understanding of the main idea of the exhibition: that all the things underground are interrelated and interconnected. Respondents at this level were able to indicate their understandings to us during interviews:

> Well, I guess this exhibit made me more aware of their whole role in the whole. [061404-I]

> I learned that it's a cycle, I learned that you can make soil richer, there's a lot of uses for soil….animals help the soil and the soil helps them for like food. They eat it, then digest it to make richer soil. [061901-I]

> …I guess what kind of got to me was the way that insects and plants work together…their relationship…the way that the roots of plants follow the paths of the insects. [062003-I]

> And it opened up your eyes to other things that you didn't even imagine… We often look at what maybe a dung beetle does, but how something else is maybe reliant on what that animal organism does. So I think in a soil level it puts the perspective of how everything is interconnected in a very visual form. We get wrapped up in everyday things, that's just here, this is the basis of everything. [042501-I]

The exhibition, especially the Teaspoon of Soil exhibit unit mentioned specifically by respondents, seemed to the move some people to this level. However, most respondents remained below Level Three.

Level 4

I am part of that interrelationship.

A Level Four understanding of the exhibition included a realization and appreciation of the fact that human beings are part of the equation, and that what goes on underground is not just something that humans observe as an outsiders. A few respondents articulated this level of understanding:

> I was thinking that the soil, as much as it relates to nature and how we need it. I'm hoping we're not polluting it. [042601-I]

> There's more to the soil underground rather than the top that we're so familiar with. And that there's more to a lot of care that needs to be done.…We just take the soil for granted. There's more than just the dirt that we step on. There's more life to it underneath. [061404-I]

> …there's an interconnectedness and an interrelatedness between all the different components in the soil underground, and how, because we're so big, we're not aware what goes on beneath our feet necessarily. And it's important—or it helps if we can bring ourselves down to that level. Hence, the shrinking process. And we can see exactly what goes on underneath our feet….its main purpose is to change your perspective by inserting you, the viewer, at a different level into that ecosphere, or that biosphere. [061701-I]

The majority of people whose knowledge corresponded with Level Four appeared to have been at this level before entering the *Underground Adventure*. The gardeners we interviewed seemed especially likely to be at least at a Level Four before visiting the exhibition:

> When I garden it crosses my mind a little bit. I try not to throw stuff in my garden that I think would not be… recyclable or wouldn't decompose. [042601-I]

In the case of this respondent, the exhibit may have reminded her of her existing knowledge. The exhibit may also have helped Level Four people articulate their understandings, since they often cited the Advance Organizers or the Conclusions quotes when explaining their thoughts about soil.

Level 5

I appreciate how important all of these interrelationships are to the health of the planet.

A Level Five understanding indicated a more sophisticated understanding of the interrelationship between soil, humans, and the health of the planet. It included a deep appreciation for soil, including a sense of stewardship (and, perhaps, activism) and a desire to do something proactive. For example, a few respondents spoke about this sense of responsibility to the soil:

> Yes. I liked the quotes.…I think each one of them talked about they don't treat the earth with respect and the kind of view it as old dirt…We don't really think about if you don't treat it with its own due respect, that it's not going to support us. [051803-I]

> The ecosystem…is something that everyone needs to respect. I think that's a good word to use. People have a tendency to abuse the ecosystem. They should learn about that. [052202-I]

This level of knowledge was even less common among respondents than Level Four. As we saw in Level Four, the small number of respondents at Level Five seemed to have already reached it before visiting the exhibition based upon what they mentioned about their experience with gardening, their interest in environmental issues, or their religious beliefs. The exhibit may have reinforced this position on the knowledge hierarchy, but did not tend to move our respondents to Level Five.

Messages

By examining the messages that respondents took away from the exhibition, we can more fully understand the visitor experience and assess what people learned from the *Underground Adventure*. By understanding the messages perceived (or not) by visitors, we can also identify areas for improvement within the exhibition.

While the *Underground Adventure* intended to communicate four main messages, which were mentioned earlier in this report, the exhibition contained a variety of intended and unintended messages. We grouped these messages into three categories:

1. Perceived messages—those that the exhibition team wanted people to understand and that respondents *did* carry away from

the exhibition.

2. Missed messages—those that the exhibit team wanted people to pick up in the exhibition, but that respondents did not.
3. Expected messages—those that respondents wanted to hear in the exhibition, but did not.

Each category of message is discussed below.

Perceived Messages

While many respondents picked up the first two main messages (that many things live underground and that they are connected to one another), fewer respondents took away the messages about living things' connection to the earth's life support system and human interconnections with it.

The exhibition communicated to most of the respondents in the study the message that many things live underground. For example, when asked how he would describe the exhibition to a friend, one respondent replied, "I'd tell them the *Underground Adventure* was about soil and inside the ground." [060704-I]

In viewing the exhibition, the majority of visitors interviewed also learned that many things live underground:

> Well, I think people who have visited the exhibition are more aware of the qualities of the soil, the different kinds of soil that there is and…some bugs. They're more aware that there's more than one or two bugs that live under the soil. [061404-I]

> I want to go home now and take a scoop out of the ground in the garden, take a closer look at it. See how many things we can actually see in there. Because most of those things you can't see. You dig up ground and you don't see anything. You might see a worm or a big bug every now and then. But it's just neat to know that all that stuff is there. [042801-I]

Underground Adventure had many places for respondents to pick up the messages that many things live underground and are connected to one another. For example, the walls of the Underground Experience showed a number of creatures and plants, as did the Take a Closer Look exhibit unit.

Fewer respondents in our study perceived the message that everything, including humans, is related. Unlike the other two messages that visitors we spoke with seemed to perceive in many different places in the exhibition, there were three specific places that visitors cited as bringing the interconnection messages together for

them: the Advance Organizers, the Teaspoon of Soil, and the Conclusion quotes.

Missed Messages

Missed messages were those that the exhibit team wanted visitors to understand, but that most of our respondents did not perceive. The biggest message missed by most of our respondents was that the soil portrayed in the Underground Experience was prairie soil. When asked the location of the soil, visitors had a variety of answers, but no one identified it as prairie soil. A few respondents, such as this one, simply described the type of soil:

> If you dig, you dig, perhaps, three feet under, it's still the same dirt…I guess this exhibit is focused more on like black soil and the kind of soil that has—like really rich with nutrients and life. [061404-I]

Other respondents believed it was soil from their backyard or a similar locale:

> I suppose the soil could be anywhere…like my lawn, you know, because I've got a lot of…pests on my lawn right now. [060702-I]

> The soil's the same kind as Illinois, I think. [061501-I]

> Well, it's like the stuff in my backyard in the suburbs of Chicago. [061404-I]

> It's not an altered potting soil. We're not looking at something that you would plant your geraniums in. It's trying to get people to realize that this is what is in their backyard or along the sidewalk or, you know, in a park. [061701-I]

A few respondents believed the soil was not local, much less prairie soil. When asked where the soil was from, one respondent replied:

> A farm….I'm going to say in America. Now, using that crustacean that you all had down there, I would say what? Florida? I don't know. [052202-I]

On the whole, however, respondents did not associate the soil with a location unless the interviewer prompted them.

Expected Messages

Expected messages were those that our respondents expected to receive, but did not perceive, in the *Underground Adventure*. These messages affected the experience of some respondents who were disappointed by the lack of messages regarding the touching of soil, composting, and recycling.

Touching Soil

The most common message that our respondents expected to receive at the exhibition but did not was related to the experience of touching soil. Many respondents said that they were expecting (and wanted to be able) to touch soil, even if they recognized the problems real soil presents:

> …have the dirt in there so you could say, hey, look, we just looked at this, oh, this is the real size. Oh, and wouldn't it be cool—no, this wouldn't be cool at all—if you could like have dirt that people could put that hands in. No, then they'd get dirty. [060704-I]

> Something hands-on for kids. You could have a map of composting or a real compost thing. You could also have places for kids to actually plant plants. [062003-I]

When asked what would make the exhibition better, another respondent replied that dirt to play in and to see bugs in, would improve it. The respondent's family then proceeded to discuss how dirt would require water and a way to keep the exhibit from becoming a mess. [061501-I]

Composting and Recycling

Messages regarding composting and recycling were messages that our respondents said they expected but did not find in the exhibition. Some people said they were looking for information on how to compost and were surprised that they did not find it.

> What are uses of the compost? Did I miss anything about…compost and helping the soil? [061404-I]

> I think I expected there to be something about composting. But I don't think there was….
> Was there anything about composting? [062003-I]

Other respondents complained about not receiving information about recycling in the exhibition:

> Because I was thinking right away that too a lot of stuff that I've been reading and hearing about for…Recycling ….and helping with the nutrients and help make the soil healthier by composting. So I was looking around and seeing if there was more information about how to make soil from that. And I don't know if I missed it. [061404-I]

> How do they get it to recycle? How does soil recycle? [060704-I]

A very few respondents attributed the lack of information on composting and organic methods to the fact that Monsanto sponsored the exhibit. These people felt that a chemical company may not have been supportive of organic soil conservation techniques.

Engagement

In addition to looking at the various learning outcomes for visitors and the messages visitors carry away, it is also important when assessing the nature of the visitor experience in a particular gallery or exhibition to examine the ways in which they engage with the exhibits, objects, and content (Ansbacher, 1999; Perry, 1994). In this study, in addition to the learning outcomes and messages described above, we examined four types of visitor engagement: physical, social, intellectual, and emotional. Each of these will be discussed below. It should be noted that none of these four types of engagements are any more or less important than the other. The following discussion is based on the premise that while we will talk about each one separately, the visitor experience is, by definition, an integrated interweaving of all of them. They are not, nor are meant to be, mutually exclusive constructs. When all four work in concert, the potential for learning is maximized.

Physical Engagement

The first type of engagement is physical engagement, defined as all of the ways that visitors interact with the physical space, objects, and exhibit units. It includes, for example, how visitors move through the space, if they touch things, and whether or not they read the labels. It includes how long they spend at a unit and what they do when they are there. One type of physical engagement is commonly referred to as "hands-on," although it can also include non-hands-on activity as well, such as standing and looking at an object or sitting in a theatre. By definition, there cannot be a lack of physical engagement because if visitors are in the space they are physically engaged—even if their engagement is passive.

In assessing physical engagement, it is important to analyze it in terms of three criteria: 1) Was the exhibit used in the way the exhibit developers intended? 2) Was there a variety of physical interaction? 3) Did visitors behave in ways that were counter-productive to the exhibition goals and objectives?

From our observations, we found a wide range of physical interactions throughout the exhibition. Most visitor groups we observed engaged in a variety of appropriate physical interactions including reading labels, standing and looking, touching and climbing, pushing buttons, and sitting and relaxing.

Not surprisingly, we found that for most respondents, the physical engagement in the Underground Experience was richer and more varied than in the Mud Room. In the Underground Experience, we saw visitors engaging in a variety of physical activities including climbing in the cicadas, interacting with the video screens, touching the water droplets on the walls, and feeling the texture of the walls. Respondents, however, also engaged with the exhibition in unintended ways, such as running through the walkways, sitting on the video monitors, and dancing to music from the videos.

In a few cases, we observed very limited physical engagement in the Underground Experience—for example, when a fearful child pulled their adult caregiver by the hand with the apparent intent of getting through the space as quickly as possible.

> …the girl pulled her mother through the Underground Experience, denying that it made her feel uncomfortable. She seemed to be really uneasy in this space. Part of it may have had to do with it being very crowded that day. They seemed to feel more comfortable in the second half of the exhibition. [040401-D]

In these cases there was very limited reading of labels, looking at the objects, or touching walls or objects.

We also observed that physical engagement for children five and under was somewhat limited. In many cases they could not see exhibits above their height, which meant that their adult caregivers spent quite a bit of time lifting them, which resulted in fatigue.

Not surprisingly, we found that physical engagement in the Mud Room was quite a bit different than in Underground Experience. There was less of a range of types of physical activities in this room, probably because it is a more conventional space with counters, chairs, and computer monitors. Observed behaviors included standing against the Measure Wall, sitting at monitors, pulling a rope, pointing at a specimen, and looking through a magnifying glass. One somewhat surprising occurrence in the Mud Room was a set of parents who sat on the floor while their three children explored the interactives[052001-D].

In the Connections area and Theatre, most respondents used the spaces as intended. Although fewer visitors we observed stopped in these areas, those that did tended to read the labels, look at the objects in the cases, sit quietly on the benches, and watch the movies. In both of these areas, we observed a few children using the benches as a gym

to climb on and practice gymnastics moves and using the Drum Cases as drums.

In the Conclusions area, most visitors we observed stood to watch the Quadroscope or walked right through the area, though at least one child tried to climb into the Quadroscope. A few visitors we observed stood to read the Quotes. The majority of our respondents spent very little time in this area and those that did tended to spend most of their time standing quietly and watching the Quadroscope. At the time of data collection, there was no place to sit in this area except for the floor. Since that time, a bench has been installed, which may help visitors linger longer.

Social Engagement

Much of the recent museum learning research and theory focuses on the role of social interaction and collaborative meaning-making (Borun, Chambers, Dristats, & Johnson, 1997; Borun & Dristas, 1997; Diamond, 1986; Hein & Alexander, 1998; McManus, 1987; McManus, 1988; Perry, 1989; Perry, 1992; Perry, 1993a; Silverman, 1995; Silverman, 2000). This body of research and theory stresses the social aspect of the museum visit as an important educational tool. It stresses that visitors to museums tend not to learn from the exhibit itself, but rather from each other. This body of literature indicates that it is when visitors talk about the exhibit, artifacts, and their experiences in the exhibition that learning takes place.

In this study, we examined three types of ways visitors tended to engage with each other socially: 1) sharing personal experiences and memories, 2) sharing surprising knowledge and revelations, and 3) developing deeper understandings.

In our observations of and discussions with respondents for this study, we saw evidence of all three types of social interactions in all areas of the exhibition. When sharing personal experiences, a common interaction was respondents talking with each other about animals they had seen previously in other settings. A few talked with each other about gardening and/or spiritual experiences they had. Some visitors we talked to or observed in the Underground Experience explained why they did not like a particular animal or they recounted a story about why they were afraid.

We did not encounter many statements of surprise or revelation. However, a few respondents talked with each other about how they did not know, for example, that so many things lived in a teaspoon of soil.

The third type of social engagement we looked at—developing deeper understandings—includes a range of teaching-learning interactions such as directing someone's attention to something, explaining a phenomenon or concept, asking/answering a question, reinforcing a concept, discussing an idea, relating content in one exhibit to ideas in another, group problem-solving, and reading/interpreting a label aloud. Throughout the exhibition, we observed most respondent groups trying to engage in many of these behaviors. One common social interaction we observed involved an adult caregiver reading a label aloud to a child. In most cases, initial teaching-learning exchange was not followed up by any further discussion or explanation and the exchange ended there. A few adult-older teenage and adult-adult groups were more successful at using the label as a jumping-off point for further exploration.

Other frequent social engagements we observed included adults reinforcing the fantasy aspects in the Underground Experience and directing children's attention to interesting parts of the exhibition that they would otherwise have missed. We also observed that in the Mud Room, parents tended to lecture more than in the Underground Experience. At the What's What exhibit we observed some group problem solving as respondents argued about the characteristics of various bugs.

It appeared that on the whole, most adults needed some help and direction to effectively engage their children in developing deeper understandings of the content of the exhibition. Most parents attempted to help their children learn from the exhibition, but many were unable to do much more than read the labels aloud.

Intellectual Engagement

The third type of engagement we examined in this study was intellectual engagement, defined as how visitors think about the content of an exhibition. Whereas physical engagement is what the visitor does physically in the exhibition, intellectual engagement is what the visitor does in his or her head. Intellectual engagement is often referred to as "minds-on" in contrast to the "hands-on" of physical engagement. It includes thoughtful behavior, reflection, and analysis—mulling over what is experienced and relating it to the visitor's own life. It also includes scientific inquiry skills, such as observing, identifying attributes and relationships, comparing and contrasting, classifying, and hypothesizing.

The nature of the intellectual activities varied for many respondents depending on the part of the exhibition they experienced. In the Underground Experience, respondents typically used their sense of

touch to explore and learn about the environment. Most of the intellectual engagement we observed was limited to identification of species. We observed many respondents pointing at things they saw while simultaneously naming them. "Oh look. That's a…." was a common expression.

The Mud Room, on the other hand, was more of a cognitive experience and elicited a wider range of intellectual interactions. One young respondent described it as "like a library." [061901-D] Some exhibit units stimulated more meaningful intellectual engagement than others did. For example, the What's What exhibit required respondents to pay close attention to the critical attributes of different insects, whereas at Rambling Roots, children seemed primarily engaged in the physical activity of pulling the rope. Most adults, on the other hand, appeared to grasp the idea behind the Rambling Roots quickly and readily made comparisons between the lengths of the various root systems.

In the Connections area, a few of the relatively small number of respondents we saw who used this area spent time relating what they saw to their own lives and entered into thoughtful discussions with their companions.

In the Conclusions area, the Quotes appeared intellectually stimulating for the respondents who read them. Meanwhile, the Quadroscope was also intellectually engaging to some people, like the person who pointed at it and said "That's the earth; that's where we live." [061404-D]. Yet it also mystified a few respondents, such as the one who wondered if it showed "how bugs see." [051702-D]

Emotional Engagement

The final type of engagement we examined was emotional engagement. More difficult to define than the three previous types, emotional engagement includes all the ways in which visitors experience the exhibition in an emotional way. It involves the ways and extent to which visitors experience emotions such as fear, awe, fascination, mystery, or skepticism.

Not surprisingly, the strongest emotional engagement we observed was in the Underground Experience. Visitors we observed or interviewed indicated a wide range of emotional experiences, from fear to playfulness and enjoyment. Some respondents laughed out loud, whereas others were apprehensive about what might be "around the corner."

Many visitors we observed appeared pleasantly surprised by critters

they stumbled across, and others seemed excited to be in such an environment. We observed most visitors having a fun, lighthearted time in the Underground Experience.

> The group of women approached the Wolf Spider. The same woman that danced at the Movement Videos shivered in mock fear while laughing at the bug's flailing leg. [61404-D]

On the other hand, fear was a common emotional we observed in our respondents. A few adults expressed mild apprehension, while children six to twelve tended to talk about "good fear"—a scary, yet fun feeling that makes the experience exciting for them. Almost all children five and under that we observed showed a real sense of fear while in the Underground Experience. This fear could be so intense that it prevented them and their families from completely enjoying their visit. There was evidence that a few respondents would choose not to go into *Underground Adventure* because they did not want to experience the emotions associated with dark and confining spaces and/or oversized bugs.

In contrast to the Underground Experience, the Mud Room elicited a narrower range of emotional interactions in virtually all observed visitors. Some visitors used the Mud Room as a safe place to recover from their fear of "being underground," whereas others appeared to settle into a mode of "intellectual curiosity." The Theatre, in particular, appeared to elicit some fairly strong emotions that will be described later in this report. In addition, a few visitors expressed a strong emotional engagement with the Conclusions area of the exhibition, which again will be described in a later section.

Finally, a few visitors expressed frustration with their visit to *Underground Adventure*, primarily because either they had paid for the exhibition and felt it was too crowded with school children, or that it was designed specifically for children and not for them—or both. With these visitors, the emotional frustration appeared to override any other emotional engagement they might otherwise have had.

Personal Connections

When describing the visitor experience, it is often useful to talk about visitors' personal connections in addition to describing the messages they took away and the ways in which visitors engaged with the exhibition. We have found from previous studies that while visitors' experiences tend to be multi-faceted, rich, and complex, any particular visitor tends to form a primary way of thinking about and engaging with the exhibition and its content and objects. Visitors tend to

develop a certain perspective or framework from which they experience and remember their visit. While the museum may be thinking primarily of the exhibition as an environment within which the visitor can develop a greater understanding of and appreciation for the exhibit content, the visitor often develops a very different primary connection.

For some visitors, a personal connection with an exhibition may be primarily as a form of entertainment as a fun place to take their child on a Saturday afternoon. Other visitors may think of that same exhibition as a spiritual link to some inner part of themselves, while for still others it might be all about the science behind the objects. Often the personal connection is the first thing that visitors will describe days, months, or even years down the road when remembering the exhibition visit.

While every individual's connection to an exhibition is unique, we have found that with most exhibitions, some common connections emerge from the data. In this study, we identified six primary ways that visitors appeared to think about and connect with *Underground Adventure*: experiential, fear, entertainment, previous experiences, transformative, and boring. These will be described below.

Experiential, visceral, tactile

A common connection to the exhibition that appeared among our respondents was an experiential one. Respondents who connected to the *Underground Adventure* on an experiential level described the exhibition in terms of what it felt like. In particular, they focused on the look, sounds, and feel of the Underground Experience. They talked about the big bugs, touching the walls, and what the exhibition smelled like or described the experience of being underground. For example:

> It showed what it would be like to be underground and…what's really there and what you don't see. And just like something you might take for granted, like from not being in the ground. [042601-I]

Respondents who demonstrated an experiential connection with the exhibition tended to focus on the Underground Experience and did not talk much about the Mud Room or other areas. Not surprisingly, respondents with a strong experiential connection to the exhibition tended to be children.

> The three- and a half-year-old did a lot of touching and looking and also listened to the ambient sounds. This added to his experience, and I think it was a lot more engaging. [060301-D]

Fear

Another common way respondents appeared to connect to the exhibit was through fear. Fear, of course, is normal and can be good because it presents a challenge and helps people grow. Fear can also serve to make an experience memorable. Kids like it to a certain extent, yet fear can sometimes inhibit learning and be counterproductive.

For parents skilled in dealing with their children, and for folks who have an opportunity to return to *Underground Adventure*, fear can be a good thing. For others it could be counterproductive, focusing attention on basic survival and/or preventing them from going inside in the first place. For example, some adults chose not to go into the *Underground Adventure* specifically because they were afraid of bugs. Some children were unable to overcome their fear.

The need to deal with children's fears certainly reduced the effectiveness of the Underground Experience for almost all the families with children five years old and younger.

> As soon as the kids got to the underground part, they got scared. They wouldn't go past the area where the penny was. The moms stopped there with them to reassure them that this was just "pretend." They kept making comparisons to *Honey, I Shrunk the Kids* as a way of telling them it was pretend. A couple of the kids wanted to be carried. The kids reluctantly followed, although they occasionally still asked if they were almost done or if it was real….They invited the kids to touch the roots and the soil so they could see it wasn't real. One adult touched some of the bugs so they could see it wasn't real also. They did this throughout their visit. [042802-D]

> The boy asked to be held by his father and seemed to want to go home. He didn't want to come too close to the cricket and said that it was "too scary today." [033001-D]

It seemed that success exacted a cost—the effective components of the Underground Experience also could be frightening, especially to children five and under. Perhaps fear is an inevitable consequence of exposing young children to immersion experiences and giant animals. Normative data on children's fears show that two- to four-year-olds consider large animals and dark rooms—all of which are present in the Underground Experience—to be sources of fear (Robinson, 1991).

Elsewhere in The Field Museum, we have seen young children scared by the simulated Egyptian tomb and a walk-through Coal Age Forest, and certainly children have been frightened by The Field Museum's

exhibits of life-sized dinosaurs, with or without the skin. For that matter we've seen preschoolers petrified by costumed figures as seemingly innocuous as Barney the Dinosaur. Two- to three-year-olds appeared to be most fearful during the Underground Experience:

> The two-year-old was afraid. The four-year-old, she's not afraid. She was just acting silly….She just likes acting baby. The two-year-old was a little scared at some of the things that were big….She didn't want to go near the big spider. [051703-I]

Child respondents over five-years-old sometimes talked about "good fear"—they admitted being afraid, but they said they liked it. One family's (that included a five-year-old boy) experience illustrates the duality of fear.

> At that point, the animatronic started to move. The boy was visibly scared and started backing away. His dad held him. [052501-D]

Yet, later in the visit,

> The data collector was very surprised that the child wanted to go back to the Underground Experience. He was clearly scared at different points in the Underground Experience yet something intrigued him enough that he wanted to go back. This suggests that there is a "good" kind of scary that some kids enjoy. [052501-D]

This scary, but fun, feeling was most apparent in elementary/preteen respondents. For example, "His eleven-year-old daughter said it would be spooky at Halloween. A cool place to be at Halloween." [042801-D]

Fear can be considered a cycle. As Robinson, Rotter, Fey, and Robinson explain, "The more children successfully handle such situations, the less vulnerable they may feel." p. 191 (Robinson, 1991) We have seen a few children begin to conquer, or at least suppress, their fears over the course of a single visit to Underground Experience:

> This mother read and talked a lot. It was as if her voice quickly soothed her son's fears. As they entered, he seemed quite tense. After his mother knelt down and told him they were underground, he seemed to relax. He never exhibited fear in any way again while they were in the exhibit. [060703-D]

Furthermore, our limited longitudinal data suggested that young children proudly outgrow their fears. For example,

> Making several visits seems to make a difference in getting kids acclimated to the exhibit and not being too scared of the underground experience. The four-year-old seemed pretty comfortable during the visit. While the three-year-old was a little skittish, overall, he seemed to enjoy some of what he saw. [033001-D]

We tried experimenting with the fear factor during depth observations by preparing a child respondent by describing the upcoming Underground Experience. This preparation may help them control their reactions to fear by providing them a sense of power, but it did not seem to eliminate fear entirely.

Entertainment

Another common connection to the exhibition was to regard it as a form of entertainment. Respondents who connected to the *Underground Adventure* in this way often described it as fun or Disney-like, and they enjoyed the make-believe, fantasy aspects of the Underground Experience:

Like the people whose connection was experiential, these respondents tended to focus on the Underground Experience area:

> I thought this was neat, but I just thought that was like, you know, a ride at Disney World or something. [060704-I]

> Because it's fun and exciting. It's like you don't get to see this every day of your life. [061902-I]

> I think my kids were pretty excited about it. They were running around. I thought lots of smiles. I think they liked going in the shrinking chamber. [061902-I]

> I would describe it more as walking through an exhibit, like at Disney World, where you can see everything and it shows you how it's really like. [042601-I]

Personal previous knowledge and experience

Another connection to the exhibition among the respondents we talked was based upon their previous knowledge and experience. Those respondents who connected to the *Underground Adventure* in this manner used phrases such as "It reminded me…" Adults who mentioned their religious beliefs in interviews seemed to tend to make this type of connection to the exhibition. For example, one man connected the exhibit to both his hobby and his profession:

> I just planted a garden; I tried to turn part of our backyard into kind of a reflective type of garden. So I've been back there by the tree and, you know, clearing shrubs away. You notice that under the shade especially

> that some of the dead wood and all that stuff is starting to become soil.…It was kind of interesting to see all of it here and remember what it actually looked like there. [060704-I]

He went on to say,

> It meant more to me, I think, especially getting into the movies in this exhibit about the dirt. It meant a little bit more to me because I've been thinking about that. Actually, I'm a pastor and I preached a little while back about dirt and the soil and how we got soil. And that was part of…the message during the sermon. [060704-I]

Another visitor drew on his religious beliefs when explaining how he felt about the exhibition:

> I'm fascinated because -- well, this goes back to the Bible again. OK? For me, I'm fascinated with the wisdom that God used to create things.…Like I said earlier, how many different things are needed to maintain the soil. God created all those things too. [052202-I]

Transformative

A few respondents talked about how the exhibition changed the way they think or the things they would do after seeing it. We consider these respondents to have connected to the exhibition as a transformative experience.

Respondents who made this connection to the exhibition often said the *Underground Adventure* created the urge in them to interact with soil. Perhaps because of their previous experiences with soil, gardeners who were respondents tended to express this type of connection to the exhibit.

> It made me want to go out into the garden. You know, after going through there it made me want to get out into the garden. [060704-I]

> I came out feeling like…it was good. I just wanted to dig a hole in the ground and see what's in it. [062003-I]

Others said the exhibition changed the way they thought about soil:

> We have a valley, like, right across from where we live and they're wanting to sell it and then they're like going to make a house, probably. And we shouldn't do that because there's all those animals and stuff that live there. [061902-I]

For one group of respondents, the exhibit actually changed how they perceived The Field Museum,

> It definitely made a huge impression on my children… they call The Field Museum "The Underground Museum" even though I keep calling it The Field Museum. They keep saying, "Let's go back to The Underground Museum." That's how they know it. [062003-I]

Boring

A very few of the visitors we interviewed mainly seemed to describe the exhibit as boring. Respondents who expressed this connection often felt that the exhibition was not aimed at them or that their expectations were not met:

> I kind of wish there was more to do in it. I don't know what I was thinking. But it sounded like an advertisement that would be geared more toward children. More see, touch, press a button, light, you know, moving kind of things. [051703-I]

This particular visitor was so disappointed with the exhibit that the data collector noted it in the debrief report:

> The woman said that the exhibit was boring. She was disappointed and considered it a negative to her visit. [051703-D]

Respondents' Perceptions of the Exhibition's Intended Audience

After talking with a number of visitors, a question emerged: Who was the exhibit intended for? We found this interesting because often respondents thought the exhibit was created for an age group other than their own. When asked "Who do you think the developer had in mind when creating the exhibition?" many respondents divided the *Underground Adventure* into sections, each of which had a different audience.

> But I think once it's decided who it is geared for, you can go from there. At this point, I'm not sure who it's for. It seems like kind of half and half….part for school kids and part for adults. [051703-I]

> I think visually, it's very interesting…if you don't like this part of the exhibit, you can walk a few steps and find an exhibit that would be more interesting to you. So I think, for that, I think it gives people with different ages maybe, or where they're from maybe and different things that would interest them. [051803-I]

As we mentioned earlier in the "Enjoyment" section, most respondents thought that the Underground Experience was for "kids" (elementary students to preschoolers). This perception seemed to be due to both the fantastic atmosphere as well as the tactile nature of many of the exhibits.

When asked who he thought the exhibit was for, one man elaborated on his answer that it was for five- to twelve-year-olds.

> …most museums, that's kind of what they target for exhibits like this….One of the cool things is having stuff that little kids can look down on, where you have the rice tool and some of the other things on this bench over here. By the big crayfish, you have those three holes that look down into the earth. Kids like that. [061701-I]

Another respondent echoed this same thought:

> …you just think "Is it good for kids?" And "How does it work for kids?" So I think it must be a real good hands-on one for some of the kids. You see them running up to the screen, poking buttons and looking at them. [061501-I]

Some respondents, especially adults accompanying children, commented on the level of reading skills required to understand the labels as well as their placement.

> Well, I don't think there's any particular grade, but I say school age kids, because in order to understand what's going on in this exhibit, you have to be able to read the signs, and little kids can't read the signs. You know, they like to just push buttons and see things light up. Like every time we passed a button, she wanted to push those buttons. [051702-I]

Because of the reading skills needed to use the interactives in the Mud Room, this area was considered by our respondents to be more for middle school students, high school students, and adults.

> After the visit, the data collector asked the father about whether this was a "typical" visit to this exhibit. He said it pretty much was and that his young kids do tend to lose interest in the Mud Room. He commented that the Mud Room makes the message more "abstract" for kids. [033001-D]

Respondents overwhelmingly considered the Theatre and the Conclusions area to be for adults:

> I didn't particularly like the film thing….I think that some of that was not appropriate for children. [061902-I]

> The theatre seemed like—it seemed very adult….I don't think that could hold a kid's attention. [051702-I]

Respondents also considered the Conclusion quotes to be targeted toward adults, for example, one respondent said, "I maybe feel that for a younger audience the quotes were a bit obscure, they were almost directed at the adults." [062003-I]

The Experience for Families with Children Age Five and Under

We observed many small children (ranging from infants to early elementary-age children) in the *Underground Adventure*, but their experience tended to be less rich and educational than that of older children and adults. Furthermore, because these children aged five and under were always accompanied by family members, their less-than-optimal experience also affected the experience of the entire family. In addition to the negative effects of fear discussed above, the problems with the experience of young visitors and their families tended to be caused by either physical placement of objects or the amount of labels and their advanced reading requirements.

Physical placement of exhibits (with some notable exceptions like the glass wall in front of the earwig and the holes in the floor near the crayfish) were problematic for five-year-olds and younger children. Virtually all families with children of these ages who we observed were seen repeatedly lifting the children in order to view or interact with exhibits in the Underground Experience.

> It hadn't occurred to the data collector that there were so many issues with height at this exhibit. It wasn't until she saw that someone had to pick his kids up to see many things that this hit home. Mentally walking through the exhibit, there are quite a number of areas (especially the ones you have to "peek" into) that are problematic for small kids. [033001-D]

Even respondents without very young children noticed this problem:

> One thing I noticed is that—and this may be just today because of whoever's birthday party it is, most of the people in here are on the small side.…And making sure that most of the explanations…lowering them down a little bit. And some of the buttons, like the button on the wall back there is a little higher, so it disengages smaller children from wanting to participate.…She's [a two- to four-year-old visitor] having to reach up pretty high to play with that right now. [061701-I]

On the other hand, some parts of the exhibit were very accommodating to children of this age group. As one respondent explained, "…the kids would get down there on the floor and look through little windows and stuff." [052201]

Besides the physical configurations that negatively affected experience of children five-year-olds and younger and their families, reading and cognitive requirements affected the intellectual engagement of these respondents.

> So I don't think that the message about soil was portrayed as much in there for the children.…when I read it, then I understood.…But for those children…they took it as, you know, there were these little bugs, or whatever. People inside of the bug's world down underground and stuff. [052201-I]

> I thought it was going to be more kid—but I guess I've never been to this museum before. It seems like it's more for school age kids, which is fine.…Well, I think my two- and four-year-old liked the running around. I don't think they got the exhibit. [051703-I]

Reading also proved to be difficult for even for some older children:

> We had trouble getting our twelve-year-old to stay to read the signs. He just kind of started walking through it. We had to make him stop and pause and everything. [060704-I]

This respondent went on to say,

> But if you can just get them to read a couple of things, and if there is a thing like…a little pick up this phone and that's cool, look at this little video and that's cool, and it's a one-minute video…and it tells you this stuff. Instead of it just being you have to read it, it's on the thing. [060704-I]

Because the Mud Room interactives required a considerable amount of reading and were more conceptually complex than the Underground Experience exhibits, it is not surprising that the Mud Room was even less successful for children aged five and under we saw. A pattern emerged as we observed these smaller children and their families in this room.

> The data collector was struck by the fact that the Mud Room didn't work for them…there's just not much for little kids to do besides look at a few specimens. This same thing happened with an observation with a father and his kids.…if what's happening is that the Underground Experience is more accessible to kids whereas the Mud Room is more of an adult (or older kids') room? [042802-D]

> The interactives in the Mud Room are still not very successful for kids. How long it takes to make soil was something an eight-year-old girl didn't get. This was

true of the prairie roots too….she realized they were long, but that was about it. Kids are more interested in pulling on the rope than in what's happening. [050901-D]

Results and Analysis 2 – Areas of the Exhibition

Overview

Because this evaluation is both summative and remedial, part of the purpose of this report is to help the Field Museum improve *Underground Adventure*. In order to do this, the museum needs to know what works well (and what does not work so well) in each exhibit area. While the previous section detailed our findings about the exhibition from the visitors' perspective, the following section describes our findings about the exhibition from the museum's perspective by addressing the seven distinct areas of the exhibition: the Advance Organizer, Base Camp, the Underground Experience, the Mud Room, Connections, the Theatre, and Conclusions.

Advance Organizer

Visitors we observed who walked on the frosted side of the cases, tended not stop to at them.

The Advance Organizer was the row of Plexiglas exhibit cases at the entry to the whole exhibition. Before visitors even reached the ticket desk, they passed by these cases. The purpose of these cases was to alert visitors to the exhibition (since it was nestled in a corner) as well as to spur visitors to think about soil before entering the exhibition proper.

We observed visitors walking by the exhibit cases without stopping. This observation is not surprising given the location and layout of the entrance to the exhibition. In most of these cases, the observed visitors approached the exhibition in such a way that they saw only the rear of the exhibit cases.

Another factor in visitors missing these cases was the positioning of Museum staff. During our data collection sessions, a uniformed attendant stood outside of the entrance at the curve of the ramp (after the Advance Organizers). These staff members greeted visitors as they approached and directed groups up the ramp and away from the Advance Organizers. This interaction usually ensured that visitors we observed walked right by the cases.

Most visitors also paid an additional fee for the *Underground Adventure* exhibition. It is likely that the observed visitors did not make the connection between the exhibit and the Advance Organizer cases because the cases were situated *before* the area where tickets are checked and, if necessary, purchased.

In some situations, we observed visitors who did stop at the cases. When they stopped, they engaged in meaningful social interactions,

pointing things out to each other and talking about things that they had not really thought came from the soil. In addition, when we talked with visitors who had stopped at the Advance Organizers, it appeared that they had a fuller appreciation of soil's role in our lives. One group of visitors explained that they knew that *Underground Adventure* was about soil, because they had seen the Advance Organizers.

> If visitors don't see those boxes with the soil, the jeans, and the cans, they lose the whole concept. They wouldn't know until they got into the Mud Room. [052201-I]

From the visitors, and from our own observations, it is ostensible that the Advance Organizers could work to set the tone and establish a context for visitors as they start their *Underground Adventure*.

Base Camp

Base Camp operated as a holding area and did a good job of that goal. However, it was not as effective at setting up the experience as a whole. The Field Museum's timing data shows that over 70% of visitors in the study stopped at the monitors in Base Camp for at least two seconds. From our data, however, it appeared that folks did not spend much time at Base Camp, or watch the videos, unless there was a crowd and, as a result, entrance to Underground Experience was held up. The visitors we observed generally did not slow down until reaching the shrink chamber, which seemed to work well. Moreover, our respondents did not understand the science lab fantasy despite going through Base Camp. Even though it was a nice holding place for crowds, enhancement of this space is needed to make it effective at setting up the experience.

Underground Experience

The low light levels and textured walls in the Underground Experience gave visitors a sense of being underground.

The Underground Experience tended to work well in giving most of our respondents a feeling for being underground, but worked less well as a learning environment. Nonetheless, the sequence of the Underground Experience coming before the Mud Room was successful. Visitors we observed seemed to enjoy and responded to having concepts introduced in the fun, cool environment before the more structured learning environment of the Mud Room.

The Underground Experience simulated a particular environment—a micro soil laboratory in the top few inches of a prairie soil—and it asked visitors to experience this environment in a particular way, i.e. as visitors to the laboratory, shrunk to less than an inch in height. To be effective, the exhibit had to inform visitors where they were and what was happening to them, and then immerse them in the

experience, making them feel like they were there and perhaps inspiring them to play along with the fantasy. There were five major components to the immersion experience: the Shrink Chamber and shrinking experience; the soil environment; the life within the soil environment; the prairie soil; and the laboratory fantasy. Each topic is dealt with separately below.

Shrinking

This area worked well and set up the shrinking fantasy for both adults and children. Some folks have said (not in a negative way) that it was a Disney wannabe. Everyone we observed or interviewed indicated that they understood that they are supposed to have shrunk, but that they know they did not. In contrast, the "un-shrinking" experience was insufficient.

The Shrink Chamber and associated exhibits in the Base Camp were very effective at informing visitors that they were supposed to be shrinking; almost everyone we observed and talked with seemed to know what was happening. Although some respondents described the experience as "hokey," most seemed willing to play along with the fantasy. Adults often coached their children as they walked through the Shrink Chamber so that even young kids understood that they were supposed to be getting smaller.

A few children were frightened by either the shrinking technology or by the thought that they might actually be shrunk. One preschool visitor stated: "I want to get back to normal size again!" [060702-D]

The enlarging experience at the other end of the Underground Experience seemed to disappoint many visitors; they appeared to perceive it as anti-climatic. One father supplemented the experience: he had his son cover his eyes, moved him forward a few steps, and said, "Okay, we're not shrunk any more." Other visitors just measured themselves and moved on.

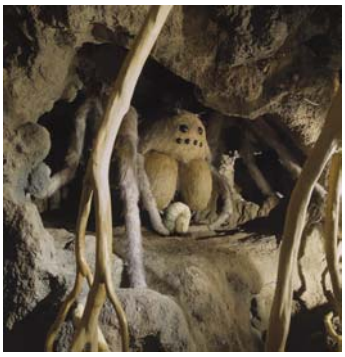
Soil Environment

The Underground Experience was very effective at helping visitors realize that they were visiting the soil. The dark-but-not-too-dark lighting, rough-textured walls, winding passages, frequent cul-de-sacs, and ambient sounds all contributed to the soil experience. At least one visitor claimed she could smell the soil when she was near the first of two smell generators in the exhibition.

Most visitors we observed seemed engaged by the soil experience. They touched the walls, explored the passages and cul-de-sacs, and discussed what was happening with their companions. However, almost all the children aged five and under who we observed seemed

frightened, and sometimes started clinging to the adults even before they saw the first giant bug.

Soil Life



The wolf spider is one of the soil animals portrayed in the Underground Experience.

The exhibit was also very effective at helping our respondents realize they were seeing soil animals portrayed at much larger than life size. Perhaps the exhibit was too successful at portraying soil animals; not surprisingly, animals dominated many respondents' discussion of the exhibit. Our respondents' experiences with plants, fungi, microorganisms, and the soil itself seemed secondary at best.

One reaction we were encouraged by was people playing along with the fantasy by talking to the animals, cringing in mock fear, or shouting, "Run for your life!" Of course, almost all the five-year-old and younger children we observed expressed real fear at some point in the Underground Experience. If they had not asked to leave the exhibit earlier, we often observed the mole cricket or earwig triggering these children's flight responses.

Adults were also observed to be at least mildly frightened or disgusted by the enlarged "bugs." In these cases, respondents were observed walking carefully down the middle of the path and avoiding any possible contact with the giant creatures. One adult respondent insisted that she walk by the wolf spider with her eyes averted.

Families with children five-years-old and younger also faced another problem that reduced the effectiveness of this part of the exhibition. Many of the viewing holes, cases, videos, and interactives were placed above preschoolers' heads. Preschoolers needed to be held by a parent in order for the children to touch the Movement Video screens, in particular.

Prairie Soil

The exhibition was not effective at informing our respondents that they were exploring a prairie soil. Since most visitors we spoke with probably did not think to ask, "Where are we?" as they entered, the video and label interpretation about prairies did not sink in. Once respondents were deep inside the soil, a few began to wonder where they were, but at that point they could not find enough clues to answer their question.

Would the Underground Experience have been more successful if it portrayed a more familiar environment, such as a suburban backyard? It was difficult to explore this idea with respondents, because they did not think much about where the soil was located.

Laboratory Fantasy

The part of the fantasy where visitors are supposed to be visiting a micro soil laboratory was ineffective for the visitors with whom we spoke.

The exhibit was not effective at helping visitors understand that they were visiting a laboratory where scientists study soils and soil life. Although the soil-lab message was pushed in the introductory videos, in labels, and in many details of the wayside exhibits, almost no visitor we talked to seemed to pick up on that aspect of the storyline. Perhaps the concept of a micro soil laboratory is too challenging for visitors because it just does not match the way they think about science. Furthermore, other than in the Base Camp videos, visitors see no depictions of scientists in the exhibition that might help to reinforce the laboratory fantasy. Another related issue is that the soil-lab concept was carried through to the high-tech look of the exhibits, and a few respondents commented that this design detracted from the "naturalness" of the experience.

Disney-esque

Because of the immersive nature of the Underground Experience, we were not surprised that many of our respondents compared their experiences to the movie *Honey, I Shrunk the Kids* or to immersion experiences at Disneyland or Disney World. We also heard references to Universal Studios, the Rainforest Café, the Magic School Bus, and 1950s-style horror movies. These earlier experiences helped prepare visitors for the Underground Experience in several ways.

Most of our respondents were familiar with the fantasy of humans being shrunk by high technology and were not startled at the sight of giant animated bugs along the tunnels. They also had some idea how to behave in an immersion experience. Unlike many museum professionals, almost all of our respondents seemed to use the term "Disney" in a neutral or positive way. "Disney" was a descriptive term for a familiar type of experience, and it seemed to elicit positive memories from respondents.

It is also interesting to think about ways that visitors' experiences in the Underground Experience differed from a Disney, amusement park, or other dark-ride experience. Visitors were not exposed to the sudden, shocking events or dazzling sensory stimulations common to commercial entertainment (i.e. they were not overly emotionally manipulated). Although some respondents seemed to expect these stronger stimulations and expressed disappointment when they did not experience them, most (except the children who did not like being

scared) seemed comfortable with an exhibit that engaged their senses without overwhelming them. Because they were walking at their own pace, visitors could explore to whatever depth they wanted, talk with their companions, or leave immediately if they didn't like what they found. In many ways, visitors were free to make their own experience—contemplative, social, fun, educational, or some combination—rather than react passively to a prefabricated, one-size-fits-all entertainment.

Educational Effectiveness

Overall, the Underground Experience tended to be most successful at creating an environment and a feeling of what it would be like to be able to go underground. Most of our respondents appeared to develop a deep appreciation for all the critters that live underground and repeatedly demonstrated that they enjoyed the immersion experience.

The Underground Experience appeared less successful at conveying all the important content messages. This lower success rate may be because the content/educational messages compete with the immersion experience. The Underground Experience was such an immersive and playful area that respondents might not have been in the same "learning mode" as when they were in the Mud Room. It might also be the case that the Underground Experience creates a bit of a sensory overload that kept visitors from concentrating and learning. In reference to the six-level hierarchy described above, it seemed that:

Almost all visitors we talked to reached Level Two. The Underground Experience was very effective at helping visitors discover that many different kinds of animals live in the soil. In fact, many respondents cited this as the main message of the exhibition. In the front-end study, most respondents seemed to be at Level Zero or One, so this seemingly very basic understanding about soil life may represent a jump of one or two levels.

A lesser number of visitors we interviewed seemed to be approaching Level Three. These visitors learned about a few of the simpler interrelationships in the soil—bugs eating fungus, and spiders eating grubs. However, we found very few respondents who indicated a solid Level Three "all the stuff is interrelated" understanding.

A still smaller number of respondents were reminded of their existing Level Four and Five understandings. Although we found no evidence that Underground Experience in itself raised these respondents to a Level Four or Five understanding, those who already had achieved

these levels found ample opportunity to recall their existing knowledge and, in some cases, talk about it with their companions. In the front-end study, it seemed that most respondents did not think about soil much, so stimulating recollections may also be considered a measure of the effectiveness of the exhibit.

Layout and Orientation

Based upon our observations and interviews, the layout and orientation of the exhibition appeared to work well, even though a few respondents expressed feelings of disorientation and fears of losing each other. The numbering of signs worked well for those who noticed it, but not many did.

Summary of Underground Experience

In summary, the Underground Experience seemed to effectively portray shrinking and walking through a soil populated with "giant" animals. It appeared unsuccessful at communicating the prairie environment and the micro soil lab setting. The "shrinking" experience was effective and enjoyable for almost all the visitors (children and adults) we observed, while the "unshrinking" experience was inadequate for most visitors we observed. The exhibit was most successful with families with children over five years old, but was least successful for families with younger children, who were often too frightened to enjoy the experience. Adults accompanying these younger children also had to lift them to see many of the exhibits. These problems are especially unfortunate because adult respondents tended to feel this exhibit was for kids, yet it did not serve small children particularly well.

Mud Room

Overview

The Mud Room contains a variety of interactives, many of which require visitors to be able to read.

The Mud Room appeared to be effective for the older children and adults we observed and interviewed, but did not appear to be effective for families with children who could not read. One reason for this was the nature of the room itself. In the Mud Room, the content of the Underground Experience was deconstructed and expanded. It was a more conventional museum atmosphere with a variety of interactives. Furthermore, it required a fair amount of reading to understand the content.

The Name

The name, Mud Room, did not effectively prepare our respondents for this part of the exhibition and sometimes set up unrealized expectations. The few visitors we saw who noticed the name appeared to be expecting it to have actual mud in it. One parent told her children, "Oh, this way to the Mud Room! You guys love mud." [042802-D] Of course, there was no mud to be found.

Compared with Underground Experience

The Mud Room was effective at creating a different look and feel than the preceding Underground Experience, and respondents seemed to think about the two parts of the exhibition in different ways. Whereas many respondents compared Underground Experience to Disney, several compared the Mud Room to the Museum of Science and Industry. Respondents seemed to perceive that the Mud Room focused more on learning and education.

> The Underground Experience is…all fun, and then this part is gonna pull some of it together and teach you something. [060704–I]

> This Mud Room is showing more the nuts and bolts of things. [051703-D]

> In the Mud Room you can learn what you can do. Like you research and read. [061901–I]

> This room seemed a lot more educational, like there was more to learn. [060704–I]

For some respondents, especially groups with children who could not read well, the Mud Room suffered by comparison to the Underground Experience. They felt there was more reading in the Mud Room, and this was not necessarily a good thing:

> In the Mud Room you have to read more, so it wouldn't be interesting for little kids because you have to read. [061901–I]

A child in this same respondent group said in the Mud Room:

> …you have to read to find out stuff, but in the Underground part it seems like you don't really have to read, you just see, and you, like, catch on. [061901–I]

We found these to be particularly interesting responses, because we had thought of the Mud Room as being full of *interactive* exhibits. Perhaps because these interactive exhibits involve more

reading than some of the other exhibits, respondents perceived them as less interactive.

Families with Children Age Five and Under

Although children frightened by the Underground Experience sometimes relaxed once they made it to the Mud Room, many parents had a difficult time keeping their young children interested in the exhibits. The height of the exhibits was a problem for many parents, who were already tired of lifting their five-year-old and younger children for a better view. One parent described the interactives as "too lengthy" [042602-D]. A father of a four-year old said, "The Mud Room exhibits don't draw you in as much. It's kind of meant for older kids." [060702-I]

Overall, the Mud Room seemed to be more effective for children who could read well as well as for adults.

Perception of Size

There were indications that the Mud Room was effective for some of our respondents at helping them think about the true size of the creatures they had seen in the Underground Experience. One mother explained:

> There were a couple things, like different bugs and animals that I showed my son and said, "We just saw this in there. You know, if you were little, it would look like that, but this was the thing we actually saw," like the crayfish and whatever that other thing was. And then you had bigger animals which you didn't see in there, like mice and moles…. Well, they didn't have moles in there, but he really likes those, so you could look at the actual little snakes and the little shrimp. [060704-I]

> It kind of puts it in perspective of what you just saw, and you came out here and you could see, you know, from the top, your full self and you're looking back down at these things and realizing how small they really are. [042801-I]

However, we noticed that other visitors sometimes had trouble remembering which creatures they had seen in the Underground Experience and which they had not. Perhaps these respondents had difficulty identifying the real, natural specimens after seeing the enlarged, artificial versions. Remembering which animals were in the Underground Experience might also have been more difficult for these visitors because of the sheer number of creatures presented in the two areas.

Conservation Messages

The Mud Room seemed to be only partially effective at communicating messages about soil conservation. As noted elsewhere, few respondents mentioned soil conservation as a major

message of the exhibit. Those who did talk about soil conservation often cited the quotes in the Conclusions area, Connections, and various things they had seen in the Underground Experience.

Scientist Messages

The Mud Room did not seem to be effective at communicating how scientists study soil. Although we watched a few parents talk about scientists as they guided their children through various interactives, none of our respondents seemed to notice that "this is how scientists really study soil" was a major part of the message here. Because most visitors we observed did not catch on to the micro soil lab setting of the Underground Experience, they also missed the opportunity to connect the science-themed interactives to their soil walk-through.

Connections

While some respondents really liked the Connections area, most ignored it or used it as a resting place. The respondents who liked it found that it helped contribute to the overall "interrelationships" message of the exhibition. One respondent group in a depth observation commented that only the white males in the photo cutouts were identified by proper names.

Those respondents who read the content in the Connections area, tended to enjoy it.

Theatre

For the most part, the Theatre did not work particularly well for the respondents we observed and talked with. The format of the films frustrated some, and the content even made a few angry. However, it difficult to assess visitors' overall reaction to the Soil Theatre because it, along with the other elements in the Connections area, was often either overlooked or not visited at all.

The majority of the visitors we observed and interviewed did not stop at the Theatre, and less than 20% of those tracked by The Field Museum used it. This may be because of the limited signage explaining what was behind the doors. At some point during the time of data collection, an easel sign was placed at one of the Theatre entrances. After this sign appeared, more of our respondents seemed to at least acknowledge that what was behind the door was a part of the *Underground Adventure*. However, the Theatre was still not used by

most of the visitors we observed and interviewed. These experiences are typical of many visitors:

> The same woman glanced at the theatre, but did not go in. The other woman spent about two minutes in the theatre. [051203-D]

> I only caught two minutes of it, so I didn't really get it….I walked in and there were two pictures saying, "thank you for watching." [061404-I]

When visitors did use the Soil Theatre, they often stumbled upon it. They opened the door skeptically, as if entering into a "forbidden area." After being observed peeking into the Soil Theatre, one respondent remarked, "The door looked a little forbidding." [042901-D]

While every unit in an exhibition does not have to be used by every visitor, every unit should provide a powerful experience for the ones who do use it. Unfortunately, we found that our respondents who used the Soil Theatre were either confused or unclear on the themes or purpose of the clips. Although all of the clips had soil-related themes, respondents seemed to have difficulty associating what they saw in the Soil Theatre with their other experiences in *Underground Adventure*. "I'm not really sure what it was trying to show me. I'm not sure what they were doing.…I thought it was going to be something about plants," remarked a woman as she tried to explain why she did not like or understand what was playing in the Theatre [051703-I]. Another man stated, "It was almost like it left you saying, 'Oh, that was weird,' but I wish they'd told us a little bit more." [060704-I]

One group of visitors that stopped by the Soil Theatre included a mother with three children ranging from nine through twelve years in age. This group was memorable because the woman was offended by some of the clips. She explained:

> I didn't particularly like the film thing. I think that some of that was not appropriate for children….Well, they're on a different level. I like the ones that were made by children. The guy eating the dirt...I understand what he was doing but I don't know if the children will. It could make them think that eating dirt is okay. They won't understand. I did not like the beating down of the headstone. I don't think that was really appropriate. It seemed disrespectful. And I don't understand why that was….And then what it had to do with what you were trying to teach them. I was expecting to see something more related to what we were doing here and why the earth is important, and that was not what we saw. So we

> left. I was kind of scared of what was coming next. [061902-I]

While most visitors we talked with who had entered the Theatre appeared confused about the purpose and intent of the film clips, some did realize that the film clips were clips from submissions to a film festival. Those visitors tended to be the ones that had stayed in the Theatre long enough that they saw the explanatory text at the very end of the presentations.

> They said they liked the Theatre. The mom said that she thought it was kind of funny. The teen said that he thought it was interesting because they were all different. As they talked about it, you could see them both smiling as they thought about what they had seen. [052502-D]

> I thought it was kind of funny. It was what different people thought of making their little films. [042601-I]

Nevertheless, most of the visitors who actually used the Theatre were confused by the short film clips and did not understand how they related to the rest of the exhibition.

Conclusions

The Conclusions area used two different styles of presentation: a video projection, or Quadroscope, on one side of the otherwise empty space and quotations about soil mounted on the opposite wall. Most visitors we observed tended either to walk through the area, spending very little time, or to stop and watch the Quadroscope for a few minutes and then leave. Fewer visitors we observed read the quotes on the wall. The area was also used as a gathering place for groups that had split up in their progression through the exhibition, and also as a quiet reflection and resting place to decompress after exiting the exhibition and before proceeding to the gift shop.

The Quadroscope

Most of our respondents, especially those with children, stopped to look at the Quadroscope projection of Planet Earth; it was attractive and had an emotional impact. However, some seemed to have trouble integrating the Quadroscope with the rest of their soil experience. The Quadroscope may have seemed new and interesting, but it did not serve as an effective conclusion to *Underground Adventure*.

During our observations, the Quadroscope appeared to be the main attraction in the Conclusions area. We observed visitors, young and old, who seemed impressed by the experience. One child pointed at the projection and excitedly said, "Mommy, that's cool! Mommy! Mommy! That's cool!" [040401-D]

The Field Museum's separate quantitative timing and tracking study also found that more visitors stopped at the Quadroscope than the other elements in this area:

Attracting power of elements in Conclusions area

	Summer 2000	*Fall 2000*
Quadroscope	54%	58%
Quotes	38%	28%

Note: each sample consisted of 50 visitors

Based on our interviews, visitors' intellectual reactions to the Quadroscope were varied. When asked what the Quadroscope represented, one typical response was to describe what they had seen: "It felt like a game. It's like the whole world is getting closer and closer, and then I saw streets, saw cities, and trees and streets." [040401-D]

Other respondents tried to name what they saw. One mother pointed to the screen and said, "The Earth. It's where we live." [061404-D] A three-year-old, who enjoyed the Quadroscope so much that he wanted to climb into the screen, watched each image intently, trying to name them. He named "flowers" and "Chicago," and said the final image was "the Earth." [061301-D] A four-year-old boy asked, "Are those planets?" When his father explained that they were designs, the boy insisted that they looked like "live planets." [060702-D]

A few visitors we observed tried to understand how the Quadroscope worked. One father explained to his children that kaleidoscopes were just pictures and mirrors. [052001-D] Another response from visitors we interviewed was to relate what they saw to other similar experiences. One respondent described the images as "very Audubon" and compared the presentation to slide shows at church. [033101-I]

The bug-centered influence of the Underground Experience must have extended all the way to Conclusions, because one respondent wondered if the Quadroscope was supposed to represent "how bugs see." [051702-D] However, none of the visitors we talked with seemed to relate the Quadroscope to the messages or themes of *Underground Adventure*.

The Quotes

The Quotes in the Conclusions area were meaningful for our respondents who read them.

As mentioned above, the majority of visitors we observed did not stop and read the Quotes, but those who did often found them meaningful. The Quotes seemed effective for the minority who read them; they sometimes were cited as take-home messages for the whole exhibition. However, the Quotes also reminded some visitors of expected—and even hoped-for—conservation messages that they had not seen in the rest of the exhibit, which left them somewhat disappointed with their experience.

As stated above, The Field Museum's own tracking and timing data showed that between 28% and 38% of visitors stopped at the Quotes. While we did not gather comparable statistical data, we did observe that adults were more likely than children to read the Quotes. Well over half our respondents were family groups that included children who tended be more interested in the Quadroscope, so it is likely that adults in these family groups tended to focus on the interests of the children, and as a result, pass up the Quotes.

The Field Museum tracking and timing study indicated that the holding power of the both the Quadroscope and the Quotes—but especially the Quotes—was quite high.

Holding power of elements in Conclusions area

	Summer 2000	*Fall 2000*
Quadroscope	56%	66%
Quotes	60%	67%

Note: each sample consisted of 50 visitors

While we did not track the amount of time our respondents spent reading, the Quotes seemed to tie things together for our respondents who read them. When we asked respondents about the main messages of Underground Adventure, those who read the Quotes tended to refer to ideas from them. One respondent's thoughts were a highly condensed version of the quotes, "Wow! Soil is really important." [061603-I]

Other respondents gave more extended interpretations.

> The thing that I never even thought of—and maybe everybody knows this and I just didn't realize it—that there's no life without soil. I didn't think that way. Like in that quote that they wrote down, that's so cool. It's like it shows you how fragile life really is….If you could get your kids to stop and read some of the quotes, that would

> be cool because like one of the quotes was about if we didn't have a farm how sad that would be because you would think that really your breakfast came from the grocery store. And that's true. Like when I was a kid…I didn't realize that milk came from cows. You get it in a carton so why would you think it came from a cow. And I think we're even farther from that now.…so kids don't realize where it starts. [060704-I]

> I'm getting this from those quotes at the end. I think they were trying to teach a new respect for the fact that it's not just dirt under your feet. It's all this life and all this science going on and all these nutrients….And all you think it is dirt. Like you need to have respect for it and realize it's a valuable resource. [033101-I]

Of course, we interviewed these visitors at the end of the exhibition, right after they read the Quotes; if we had talked to them an hour later, they might have given a different response. It is also important to remember that the majority of visitors who we observed did not read the Quotes, and therefore did not benefit from their messages. That is important because, as some respondents pointed out, similar messages about the importance and conservation of the soil were difficult for visitors we interviewed to find in the rest of the exhibition. One respondent even said that the Quotes did not seem integrated with the rest of the exhibit.

A very few respondents noticed that the major sponsor of the exhibit was Monsanto and wondered if the sponsorship had influenced which messages were emphasized in the exhibit. One respondent said:

> Maybe Monsanto didn't try to influence the exhibit, but the developers still were influenced. They still maybe didn't say certain things. Maybe Monsanto said do it, but they couldn't say certain things….In the back of their minds it had to be there. I couldn't believe it. It's the first thing I said to the evaluator. I said, "I couldn't believe that there was nothing about composting and how you could promote or take care of worms and avoid chemicals." [062003-I]

Finally, during a depth observation, one respondent (who happened to be a museum professional) noticed the Quotes and asked the evaluator why there was not a single one from a female or a Native American.

Results and Analysis 3 – Exhibit Units

Overview

The seven areas of the exhibition have a variety of exhibit units. In the following section, we address five specific units in the Underground Exhibit particularly important to the visitor experience: the Penny and Rulers, the Teaspoon of Soil, the Movement Video, the Mole Tracking Station, and the Cicadas. On the whole, the exhibit units in the Underground Experience successfully engaged the visitors in physical, social, intellectual, or emotional ways. The exception was the mole tracking station, which few visitors used or understood.

Penny and Rulers

The Penny and Rulers emphasize the idea that the visitor is no longer his or her normal size.

At the beginning of the Underground Experience, a large, oversized penny served as a visual aid to reinforce the idea that the visitor has been shrunk. Nearby, an oversized ruler demonstrated for visitors the change in scale.

Most of the groups that we observed interacted with either the Penny or the Ruler—and many groups used both. Both exhibits were effective, giving visitors two different ways to think about and react to their "shrunken" sizes.

The Penny seemed to give our respondents a gut-level feel for their size, and it helped establish a somewhat whimsical tone for their adventure underground. Visitors, especially children, we observed seemed surprised and even delighted that the coin was so big. In exit interviews, respondents recalled that the giant penny had made them feel small. We watched visitors interact with the Penny in several ways. They touched it, tried to climb it, or stood next to it to get a better feeling for its scale. It was also used quite frequently for visitor photographs. However, it seemed that the most important interactions were social ones. Parents often pointed out the Penny to young children and said things like, "We're underground, now," and older children sometimes called their parents over to make sure they did not miss it.

Visitors we observed used the shrink check station to get a more exact measure of their new size. This was often a group activity, with adults and children comparing their respective measurements. This very simple interactive seemed to have a lasting effect. Many groups also stopped later at the ruler near the Underground Experience's exit, measured themselves again, and remarked on the difference. In exit interviews, children sometimes referred to their "underground size."

Teaspoon of Soil

Shortly after visitors enter the Underground Experience, they encounter a large box filled with the equivalent of a teaspoon of soil. The dirt is filled with all kinds of critters. We watched many visitors stop at this exhibit, call their companions over, examine the bugs, comment on the flashing lights, read the labels, and talk about what they saw. Visitors seemed impressed, and perhaps mildly disgusted. Their comments included: "Ugh!" "Dang!" "I hope our soil doesn't have this many creatures," and "*That's* why we don't eat dirt."

While most of our respondents appeared to enjoy the exhibit and get a lot out of it, the flashing lights confused a few. We heard some ask, "What are those? Fireflies?" and make similar comments that implied they were at least momentarily befuddled.

When we asked respondents what they were taking away from the exhibit, we heard things like:

> There were a lot of places where they impress you with how many per square foot or inch, or how many animals, how many bugs, how many bacteria. So you kept getting this message of number. [033101-I]

> It was good to see the comparisons of what you were looking at and seeing a picture of what it really was…. Pretty fascinating to see the one exhibit that said there was a teaspoon, it represented a teaspoon of dirt, and then there was a billion different organisms. And we were just saying how many times did you pick up dirt and you never saw anything in it, you know, because it's so small. That was pretty cool. [042801-I]

Many of our respondents walked out of the exhibit thinking about the large number of creatures in the soil. The Teaspoon of Soil and associated labels seemed to be effective at establishing that message.

Movement Video

The Movement Videos were fun, lighthearted, and sometimes laugh-out-loud funny. Disbursed groups often reassembled to enjoy and discuss them. They seemed to give visitors a feel for how soil animals really move, conveying the information quickly, without words. We heard some visitors asking questions that they could not seem to answer from the videos— for example, "Why do they fling themselves?"—but the lack of answers did not seem to bother them.

The music added to the experience for some we observed. It attracted visitors' attention, reinforced the mode and tempo of each

creature's movements, and made the video more fun. For example, we saw both children and adults dancing along with the bugs. However, at least on quieter days, we saw the music distract visitors at adjacent exhibits. Also, the music seemed anomalous to a few visitors—"Music? Under here?"—and may have undermined their soil experience.

The effectiveness of the videos was diminished somewhat because they were placed too high for young children to operate or see easily. One father let his three- and five-year-old sit on the unit so they could choose which clips to play [033001-D]. We also noticed that some groups missed the videos because the screen was small and surrounded by many distractions. The small screen may have deterred some visitors from watching all the videos:

> They looked over the shoulders of another family that was using the interactive video for nearly a minute before moving along. [051701-D]

Mole Tracking Station

We observed very few visitors using this exhibit. Perhaps because of the competition from nearby giant bugs and the Movement Video, it just did not seem to attract visitors' attention during most of our observations.

When we did observe visitors using the unit, they had a hard time figuring out what to do and what they were supposed to take from the experience. One respondent described it as "pointless," and another complained that music from the nearby video made it hard to concentrate on the tracking station. In addition, respondents sometimes indicated confusion between the model of the mole cricket and the Mole Tracking Station, assuming that there was a connection between the two.

Cicadas

For most visitors we observed, especially children or those accompanying children, the Cicadas appeared to work well. The Cicadas primarily functioned as a place for photo opportunities—part of the function the exhibition team had in mind when shaping this area. The Cicadas also provided a good play area for some of the children five and under. However, because the labels were on the outside of the room, few visitors we observed connected the explanatory text with the exoskeletons. Consequently, conversations in this room were not particularly meaningful on an education level.

Conclusions

Overview

This section summarizes the findings presented in the "Results and Analysis" sections from both visitor and museum perspectives. Since this evaluation is also remedial, we present our recommendations in a separate section.

The Visitor Perspective

Overall, the majority of the visitors we observed and interviewed in *Underground Adventure* had positive experiences within the exhibition that encouraged them to think about soil.

Almost all of our respondents left *Underground Adventure* at least a Level One on the six-level knowledge hierarchy. (Please see the Learning section of the Team Summary for a definition of the six levels.) Many achieved Level Two and approached Level Three on the hierarchy after their visit. The exhibition seemed to move people up the first three levels, but probably not up to the more advanced Levels Four and Five. Nevertheless, respondents who appeared to be at the two higher levels before visiting seemed to be reminded of their soil-related knowledge by the exhibition.

Of the four main messages that the exhibition intended to convey (many things live underground, these things are connected, these living things are vital to the earth's life support systems, humans are an important part of these interconnections), the first two were most clearly perceived by our respondents. Respondents tended to refer to the Underground Experience area or the Take a Closer Look exhibit when explaining where they encountered this message. Fewer people articulated an understanding of the third and fourth messages after visiting the exhibition. Those respondents who did cited the Advance Organizer, the Teaspoon of Soil, and the Conclusions quotes when explaining these messages. The message missed by most visitors we talked to was that the soil depicted was prairie soil. In some cases, respondents expected to hear more messages about composting and recycling and to be able to touch soil in *Underground Adventure*.

Our respondents engaged with *Underground Adventure* in a variety of physical, intellectual, social, and emotional ways. Physical and emotional engagement appeared most varied and rich in the Underground Experience area, while intellectual engagement was strongest in the Mud Room. Of the four kinds of engagement we studied, the social one was probably the least varied among the

visitors we observed and interviewed. Many social interactions did take place throughout the exhibition, but the depth and nature of the learning interactions (especially between parents and children five and younger) could be improved.

The personal connections that our respondents had with *Underground Adventure* fell into six diverse categories (experiential, fear, entertainment, previous experiences, transformative, boring). The vast majority connected to the exhibition on an experiential, visceral, tactile level. This connection was especially apparent in the children we interviewed, who usually referred to the Underground Experience area when describing the exhibition. Some children (especially children five and under) and a few adults connected to *Underground Adventure* through fear. With the help of parents, a few boys at the upper end of this age range (four or five years old) overcame this fear. However, most of the small children we observed were fearful, and thus they and their families were unable to experience the exhibition in a beneficial way. Another common way for respondents to connect to the exhibition was as a form of entertainment, comparing the Underground Experience area to Disney World or other commercial entertainments. Other visitors seemed to connect to the exhibition based on their previous knowledge and experience with soil or nature. A few of these visitors even connected it to their religious beliefs. Another small group of respondents described the exhibition as a transformative experience that made them think differently or affect their future actions. A very few of our respondents described the exhibition as boring because they did not think it was targeted to them or did not meet their expectations.

Our respondents overwhelmingly thought *Underground Adventure*'s intended audience was children, especially in the Underground Experience area. However, most thought the Mud Room was for older children, teenagers, or adults—all of whom could read. The Theatre and Conclusions areas were considered by most to be adult-focused areas.

While families with children appeared to enjoy the exhibition the most, families with children age five and under seemed less likely to experience *Underground Adventure* in a rich and educational manner. These types of families were forced to deal with small children who were frightened, exhibits or buttons that were too high for their children, or too many interactives that required their children to read in order to understand them. Not surprisingly, children five and under had problems controlling their fear responses mostly in the Underground Experience. They struggled more in the Mud Room

because of the high-level reading requirements of many of the interactives.

The Museum Perspective

We examined the seven exhibit units of the *Underground Adventure* (Advance Organizer, Base Camp, Underground Experience, Mud Room, Connections, Theatre, Conclusions) and five exhibit units in the Underground Experience in order to assist The Field Museum in fine tuning the exhibition.

Exhibit Areas

The Advance Organizer cases functioned as intended for the visitors we interviewed who had stopped to look at them, but we observed many respondents who did not pay attention to them because of their location and layout. The respondents who did look at them seemed to have gained an appreciation of soil's role in their lives from the content of cases.

Base Camp was more effective as a waiting area than as an introduction to the experience as a whole. When the exhibition was not crowded, most visitors we observed walked through Base Camp without stopping until they reached the Shrink Chamber. As a result, very few that we saw watched the videos that introduced the soil laboratory fantasy.

The Underground Experience area functioned well as a fun, immersive environment for the majority of our respondents, especially families with children over five years old. Unlike the soil laboratory fantasy mentioned above, almost everyone clearly understood the shrinking fantasy. Moreover, they seemed to feel like they were underground in an interesting and exciting environment populated by many different animals. A few issues interfered with the immersion experience. Some objects were too high for preschoolers to reach or view, and our respondents did not seem to understand that the soil represented prairie soil. Finally, the Reverse Shrink Chamber at the end of the Underground Experience was less successful than the Shrink Chamber at the beginning.

While the Underground Experience was quite successful as an immersive environment, it seemed less successful at conveying educational messages. The messages that respondents most commonly perceived in the Underground Experience were about many living things in the soil and their interrelation. As a result, almost all visitors we interviewed achieved at least Level Two and sometimes Level Three on the learning hierarchy. The Underground Experience did not seem to move anyone up to the more advanced levels of the hierarchy.

The Mud Room appeared to be effective as a learning environment for older children and adults. Most visitors were comfortable in the environment and regarded it as a more traditional museum setting where they were supposed to learn. The Mud Room was only partially effective at communicating soil conservation messages and was less effective at communicating how scientists study soil. Our preschool respondents, on the whole, found less to engage with in the Mud Room than in the Underground Experience, mostly due to the reading requirements of the interactives and placement of objects.

Some respondents said they enjoyed the Connections area because it addressed the human interrelationship to soil. However, most ignored it or used it as a resting area.

While most of our respondents did not watch the Theatre films, the ones who did tended to be confused by the short film clips and unable to relate them to the rest of the exhibit. While a few respondents said they understood the films and thought they were funny or entertaining, one respondent was offended by some of the images presented (i.e. the man eating the dirt and the beating down of a headstone).

In the Conclusions area, the visitors we observed tended to watch the Quadroscope instead of reading the Quotes. However, the Quadroscope seemed to be a less effective conclusion to the exhibition than the Quotes, since respondents who read the Quotes tended to refer to them when encapsulating the entire exhibit.

Exhibit Units

Overall, the five exhibit units we examined in depth within the Underground Experience area successfully engaged our respondents. The Penny and Rulers worked particularly well at setting up the "shrinking" fantasy for the people we observed. These units also elicited social interaction between visitors who often measured each other or pointed out the penny to other group members.

The Teaspoon of Soil was also an effective exhibit that portrayed the many different types of living things in the soil and encouraged social interaction between the visitors we observed. Although the flashing lights confused a few visitors, respondents often mentioned the Teaspoon of Soil when they were asked about what they learned from the exhibit.

Like the Teaspoon of Soil, the Movement Video exhibit also created an atmosphere for social interaction within the Underground Experience. Respondents were able to easily understand how soil

animals move and also have fun in the process. A few groups missed seeing the videos because of the small screens, and children five and under had a difficult time choosing the videos and seeing the screen.

The Mole Tracking Station was the least successful of the five exhibit units. Very few of our respondents were seen using this unit, perhaps because it was near the animatronic bugs and Movement Video. Those who did use the unit tended to be confused by it.

The Cicadas were successful as a photo opportunity and play area, especially for children under five and their families. However, since the explanatory labels were on the outside of the room, many families we observed had difficulties holding meaningful conversations about Cicadas while playing on the exoskeletons.

Recommendations

Overview

As stated previously, the visitors with whom we spoke were overwhelmingly positive about their experiences in the *Underground Adventure* exhibition. At the same time, once an exhibition is open to the public, and once real visitors use the space and evaluations are done, possible improvements become evident. Based on the results of this evaluation, the following is a summary of suggestions for improving *Underground Adventure*. We have divided the recommendations into the following categories:

Level 1: Recommendations that are either easy to implement and have a big impact or that are critical to improving visitors' experiences in the exhibition.

Level 2: Recommendations that are important, but require more time or more money for implementation than might be available.

Level 3: Recommendations that would be nice to have, but not essential, or those that would be more appropriate to future exhibits.

Level 1 Recommendations

Advance Organizers

Reposition—or repeat—the four exhibit cases

As described above, as we conducted this study, we noticed that visitors who had stopped at the Advance Organizer cases talked more articulately and described in more detail the important role that soil plays in our lives. These four exhibit cases appeared to make a significant contribution to at least some respondents "getting" the main message (that we are all linked and connected to soil in unanticipated ways). However, we were struck by how few visitors we saw actually stopping at the cases. One could argue that this is not surprising, considering that the cases are located in what often functions as a hallway and entranceway to the exhibition. The cases were positioned to facilitate the formation of a line into the exhibition, but the space was never used for this purpose. As a result, while the cases were designed to alert visitors to the exhibition and start them thinking about soil prior to entering the exhibition, few benefit from the simple and yet elegant messages in the cases.

We recommend that The Field Museum reconfigure this space so that more visitors naturally stop at these cases before going into the exhibition. One possibility would be to move the cases from their current location in the entryway into the Base Camp area. Our observations indicate that visitors tended to slow down anyway, once they passed the ticket desk and entered this space. Consideration would need to be taken to ensure that such a rearrangement does not create a traffic bottleneck. Systematic observation of the current traffic flow through this area under different conditions (e.g., during slow times, busy times, school group times, etc.) could help identify any potential problems.

Families with Children Age Five and Under

Add more elements for families with children five and under

As described above, there was an interesting range of visitor perceptions about for whom the exhibit was created. We found it was not uncommon for visitors who were adult caregivers of one age visitor to state that the exhibition was obviously designed for a *different* age visitor. One consistent perception appeared to be that the Underground Experience was designed for younger audiences. Connections, The Theatre, Conclusions, and (in some cases) The Mud Room were all perceived to be designed more for adult audiences, although many of these respondents indicated that the Mud Room was also for middle school and high school students.

While many visitors (particularly those that did not have children with them) held a common perception that the Underground Experience was for children, adults accompanying children five and under often commented that the Underground Experience did not have enough activities for their children. Caregivers for the children of these ages repeatedly demonstrated consternation at having to continually lift their children, and that much of the Underground Experience was not at "little-kid height." Notable exceptions were the glass-fronted earwig and crayfish displays, the cicada exoskeletons, and the glass-covered floor holes in front of the crayfish. Some adults bemoaned the fact that there was little for children five and under to touch or interact with.

We were encouraged to hear respondents talk about the exhibition being "for everyone," and explaining that it had areas for different age groups—e.g. Underground Experience for children, the Mud Room for older children, the Theatre and Conclusions for adults. However, we found that intergenerational family and social groups tended to want to stay together. This finding is consistent with research literature of family behavior in museums (Diamond, 1986). We found

that while a certain area might be successful for one age group, it often was not successful for other visitors in the same group. Ideally, more areas of the exhibition could be designed so that they work for intergenerational social groups, particularly groups with children aged five and under.

We recommend that The Field Museum consider some ways of adding spaces to accommodate families with children of this age group. In the Underground Experience this modification might include more viewing holes lower down and more objects to touch (such as a reproduction of a bumpy crayfish claw or a furry wolf spider leg). Placing permanent, small steps in a few places such as near the Habitats area exhibits or at the Root Rot exhibit could be considered. In the Mud Room, additions could include steps to climb up to the display tables (e.g., at Take a Closer Look) and, again, more things to touch at lower levels—maybe some bug puppets or other "little kid" play activities. Live animals would also be a very popular addition, perhaps in a large kid-level ant farm or a beehive.

Crowds and School Groups

Prepare visitors for crowded conditions at busy times

While most visitors spoke in positive terms about their experiences in *Underground Adventure*, we were surprised by how frequently they brought up the disruptive influence of being in the exhibition (particularly the Underground Experience) as school groups attended and/or when it was particularly busy.

We recommend that The Field Museum determine a way to make casual visitors more comfortable during busy/crowded conditions. This could be as simple as having a noticeable sign posted giving visitors a "heads up" that it is a particularly busy time, and while they are welcome to come in, the museum would recommend they return later in the day for a less hectic and more relaxing experience. Perhaps it is handing out timed tickets on busy days, or even just giving a verbal warning as people enter the exhibition or buy their ticket.

Conclusions Area

Add seating

As we described in the Results and Analysis section above, most of our respondents tended either to walk quickly through the area or to stop and watch the Quadroscope for a few minutes and then leave. Though fewer respondents read the quotes on the wall, those that did appeared to gain much from them. Because this large area also serves as a gathering place for groups that split up in their progression through the exhibition, we recommend adding benches or other

seating. Some seating has been added since this study, but additional seating is still recommended. This seating could include some whimsical bug-shaped benches. Providing visitors with a place to sit and relax would also encourage folks (who might not otherwise notice them) to read the Quotes on the wall. As we mentioned previously, these Quotes were powerful influences for those visitors who did read them.

Cicadas

Move labels to the same room as the Cicadas

As we described above, the Cicadas provided a nice spot for smaller children and for photo opportunities. However, because the labels were outside of the room, parents were unable to turn their children's interest in the exoskeletons into a teaching-learning interaction. For this reason, we recommend moving the text about the Cicadas into the same room as the exoskeletons.

Fear

Provide guidance for parents to reassure their children

The Underground Experience created feelings of fear in almost all children five and under we observed (as well as a few adults). This fear negatively affected the experiences of families with children in this age group, even though it increased the fun for older children.

In order to overcome their fears, people must feel that they have some level of power over the situation. Ideally, parents help their children gain a feeling of power by encouraging a sense of security, self-worth, and control (Robinson, 1991). For this reason, we suggest that the *Underground Adventure* provide background information, perhaps in the form of a handout, to parents with children five and under before they enter the exhibit, so they are more able to assist their children in managing their fears. This information could include ways of talking to children about what caused their fear and ways to minimize it without belittling that fear. It could illustrate how to explain to children that the object of their fear is make-believe (Peterson, 1999). We believe this information could be presented in a sensitive way that could inform caregivers of the environment of the *Underground Adventure* and how to prepare their small children for it without unduly alarming them and scaring families away from the exhibition. Ideally, this information would be tested and prototyped with visitors before being made available to all.

We also suggest that notice be given in Base Camp that the exhibit has low light levels, so that both children and adults are prepared for the environment.

Mud Room

Change the name, at least for visitors
The title of the Mud Room confused a few visitors who noticed it and set expectations that were not realized. These visitors thought they were going to be able to play with mud in the Mud Room.

We recommend changing the name of this area so that visitors are not misled and disappointed.

Connections

Add names or explanations to all photos
This area works as a quiet, reflective place. A jarring note for one respondent group was that only the photos of white males were identified by name.

We recommend adding names to all photo cutouts, or else providing an explanation of why there are not names on some of them.

Level 2 Recommendations

Composting

Provide composting information
Based on our interviews, many visitors wanted learn about composting and recycling, and expressed confusion when they did not see much about composting.

We recommend adding some information about composting and recycling. The composting and recycling information could be published in a small pamphlet on how to build a compost box or create a worm farm. This solution would also help counter any impression that the Monsanto sponsorship influenced the content of the exhibition.

Mole Tracking Station

Remove this unit and reconfigure space
As mentioned above, the mole tracking station was confusing to most visitors. It competed with the loud, nearby Movement Videos, and did not make sense to many people.

We recommend removing this exhibit unit and adding some seating in this area so that visitors can more easily watch the videos. This change would also provide an opportunity to increase the size of the Movement Video screen so that it could be more easily viewed by a larger number of people at one time.

Level 3 Recommendations

Social Interaction

Provide prompts for intergenerational social interaction

As we described previously, social interactions in the *Underground Adventure* exhibition tended to focus on allaying fear (both child and adult), orientation and way finding, pointing and directing attention, and identification of objects. According to the visitor studies literature, other meaningful social interactions that contribute to effective teaching-learning processes—and ultimately effective educational exhibitions—also include when an adult caregiver provides age-appropriate explanations, accurately answers content-related questions, asks for clarification, provides feedback and guidance, appropriately directs attention, relates objects and phenomena to things that are familiar, and asks thought-provoking questions. (Diamond, 1986; Fleming & Levie, 1993; McManus, 1999; Perry, 1992; Vygotsky, 1986). As stated previously, we observed some interesting teaching-learning behaviors, but not a particularly wide range during this evaluation.

We recommend that some interpretation be added throughout the exhibition to stimulate a wider range of meaningful intergenerational social interaction. Research has demonstrated that posting read-at-glance labels stimulates more meaningful teaching-learning behaviors (Perry, 1996) and learning increases (Diamond, 1986; McManus, 1989). Adding a few read-at-a-glance labels in both Underground Experience and The Mud Room could increase the opportunity for and improve the quality of social interaction.

For example, at Take a Closer Look, the first display cases had only creatures featured in the soil environment, yet many respondents did not make the connection between these animals and the ones seen in the Underground Experience. As a result, they missed an opportunity to discuss the animals. Perhaps a more noticeable label that says something like "Which of these did you see?" could be added. After the other cases with the creatures that were not in the exhibit, a teaspoon of soil could be added along with the question, "What else do you think lives in here?"

Reverse Shrink Chamber

Extend the exit to create a more dramatic process

The Reverse Shrink Chamber does not work for the visitors and tends

to be anti-climatic. As a result, the Underground Experience and the Mud Room, two distinct experiences, seem to be shoved together.

We suggest extending the exit of the Underground Experience over to the wall where visitors measure themselves again. This more dramatic process of reverting to normal size would better signal a transition and help people mentally prepare for a change in the experience.

Theatre

Connect the Theatre more strongly to rest of exhibition

As stated above in the Results section, the range of visitor responses to the Theatre was an interesting mix of positive and negative. Most negative responses questioned the relevance of the films. The viewers were often unable to figure out what these films had to do with the rest of the exhibition. Many respondents that went into the theatre did not understand that these snippets came from longer films, and commented on their sense of disconnection. In addition, a few respondents expressed concern about the content itself, for example, the appropriateness of showing children someone eating dirt and the disrespectful nature of beating down a headstone.

We recommend making some changes to the Theatre so that visitors' experiences here are more connected to the rest of the exhibition. Perhaps showing the entire films, rather than just snippets, and posting a schedule outside the theatre with the length of each film, with a clearer, read-at-a-glance explanation about where these films originated might be warranted. It might also be appropriate to put a "heads up" notice that some of the films might be objectionable, particularly to families with children. Another possibility might be to include a wider range of films, showing the film festival ones on some days and educational documentaries on other days.

Quotes

Add more diverse quotations

We recommend revising the Quotes wall to include quotations by a more diverse group, including people from a variety of racial and ethnic backgrounds. Since this study, quotes from women have been added to the wall.

Touching Soil

Provide an opportunity to touch soil

Based on our interviews, many visitors wanted to and expected to touch soil. We recommend adding an opportunity for visitors to touch soil and then link this experience to specific learning opportunities. A box of prairie soil could be placed in Base Camp so

that visitors could both experience it tactilely and link this experience to the type of soil they are going to be walking through in the immersive environment. A box of soil could also be placed in the Mud Room for visitors to touch after they have walked though the Underground Experience in order to further reinforce the experience.

Soil Lab Fantasy

Emphasize the soil lab fantasy with photos of scientists
As stated above, the soil lab fantasy also does not work well because many people do not watch the introductory videos or because the concept is unfamiliar to most people. No visitors we interviewed mentioned that they understood that the Underground Experience was set in a micro soil lab.

Since the all the labels in the Underground Experience are written from the premise that it is taking place in a micro soil lab, we suggest the best way to address this issue is to further emphasize this fantasy inside the Underground Experience. Placing cutouts of scientists inside the area might help remind people that this area is a lab.

References

American Psychological Association. (1994). *Publication Manual of the American Psychological Association* (4th edition), Washington, DC: American Psychological Association.

Ansbacher, T. (1999). Experience, inquiry, and making meaning. *Exhibitionist*, 18(2), 22-28.

Borun, M., Chambers, M. B., Dristats, J., & Johnson, J. I. (1997). Enhancing family learning through exhibits. *Curator*, 40(4), 279-294.

Borun, M., & Dristas, J. (1997). Developing family-friendly exhibits. *Curator*, 40(3), 178-196.

Diamond, J. (1986). The behavior of family groups in science museums. *Curator*, 29(2), 139-154.

Doering, Z. D., & Pekarik, A. J. (2000). Questioning the entrance narrative. In J. S. Hirsch & L. H. Silverman (Eds.), *Transforming practice* (pp. 261-267). Washington, DC: Museum Education Roundtable.

Falk, J. H., & Dierking, L. D. (2000). *Learning from museums; Visitor experiences and the making of meaning.* Walnut Creek, CA: AltaMira Press.

Fleming, M., & Levie, H. W. (1993). *Instructional message design: Principles from the behavioral and cognitive sciences.* (2nd ed.). Englewood Cliffs, NJ: Educational Technology Publications.

Hein, G. E., & Alexander, M. (1998). *Museums: Places of learning.* Washington, DC: American Association of Museums.

Harding, S. (Ed.). (1987). *Feminism & methodology.* Bloomington, IN: Indiana University Press.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry.* Beverly Hills, CA: Sage Publications.

McManus, P. M. (1987). It's the company you keep...:The social determination of learning-related behavior in a science museum. *The International Journal of Museum Management and Curatorship*, 6, 263-270.

McManus, P. M. (1988). Good companions: More on the social determination of learning-related behaviour in a science museum. *The International Journal of Museum Management and Curatorship*, 7, 37-44.

McManus, P. M. (1989*).* Oh, yes, they do: How museum visitors read labels and interact with exhibit texts. *Curator*, 32(3), 174-189.

McManus, P. M. (1999). What research says about learning in science museums: Watch your language! People do read labels. *ASTC Newsletter* (May/June), 5-6.

Perry, D. L. (1989). *The creation and verification of a development model for the design of a museum exhibit.* (Vol. 50 (12-A)). Ann Arbor, MI: UMI Dissertation Services-Dissertation Abstracts.

Perry, D. L. (1992). Designing exhibits that motivate. *ASTC Newsletter*, 20(2), 9-10, 12.

Perry, D. L. (1993a). Beyond cognition and affect: The anatomy of a museum visit. *Visitor studies: Theory, research and practice: Collected papers from the 1993 Visitor Studies Conference*, 6, 43-47.

Perry, D. L. (1993b). Measuring learning with the knowledge hierarchy. *Visitor studies: Theory, research and practice: Collected papers from the 1993 Visitor Studies Conference*, 6, 73-77.

Perry, D. L. (1994). The anatomy of a museum visit: What visitors really want, *The Sourcebook; 1994 Annual Meeting* (pp. 67-73). Washington, D.C.: American Association of Museums.

Perry, D. L. (1996). *Telling Images: Stories in Art. Instructional design recommendations.* Unpublished manuscript, The Art Institute of Chicago, Chicago.

Perry, D. L., & Garibay, C. (1996). *Life Underground at the Field Museum.* Unpublished manuscript, The Field Museum, Chicago.

Perry, D. L., Garibay, C., & Gyllenhaal, E. D. (1998). Front-end evaluation for *Life Underground*, a Field Museum exhibition about life in the soil. *Current Trends in Audience Research*, 11, 59-67.

Perry, D. L., & Spock, M. (1997). The informal learning program at the Chapin Hall Center for Children at the University of Chicago. *Visitor Behavior*, 12(1&2), 9.

Peterson, L.L. (April 1999). Why kids love to be scared. *Parents*, 183-186.

Robinson III, E. H., Rotter, J.C., Fey, M.A. & Robinson, S. L. (1991). Children's fears: toward a preventive model. *The School Counselor*, 38, 187-211.

Silverman, L. H. (1995). Visitor meaning-making in museums for a new age. *Curator*, 38(3), 161-170.

Silverman, L. H. (2000). Making meaning together: Lessons from the field of American History. In J. S. Hirsch & L. H. Silverman (Eds.), *Transforming Practice* (pp. 230-239). Washington, DC: Museum Education Roundtable.

Vygotsky, L. (1986). *Thought and language*. Cambridge, MA: The MITPress.

Appendices

Appendix A: List of Exhibit Names

Conventions

Heading 1 – Section of Exhibition, e.g., Underground Experience, Mud Room, etc.

Heading 2 – Specific area of an exhibit section, e.g. The Soil Nursery, Abundance, etc.

Heading 3 – An area within an area, e.g. The Earwig Area of the Soil Nursery (not all areas will have this).

Heading 4 – A stand-alone exhibit unit, e.g. the Soil Nursery Post, the Seed Nursery, or the Fungus Makers Unit.

Heading 5 – A specific element within a unit, e.g. a label or an object.

Exhibit Names

AO – Advance Organizer

Title Label

Breakfast

Jeans

Aluminum

Meds

IL – In Line

BC – Base Camp

Ticket Unit
Ticket Desk
Welcome Label

Video Monitors

Wall Labels
Emergency

What Ifs Labels
Imaginary Journey
What Ifs

Hints Label

Entrance Label

TV Preview (View Others)

Checkers Room
Room
Checkers TV (View Self)

Ruler #1

Shrink Chamber (Transmogrifier)

Ruler #2

UE – Underground Experience

UE throughout

Soil
Roots
Dirt
Bugs
Rocks
Nodules
Water

Portals

Viewing Windows

Intro

Penny

Welcome 2

Ruler #3

Mural

Depth Measure

Bench 1

Abundance

Teaspoon of soil
Lights
Everything identified for Soil above
Box Label
Count The Critters Label

Sow Bug

Abundance Post
It's Alive
Field Guide

Snail

Worm

Diversity

Beetle Grub

Diversity Post
Field Guide
Soil Supports

Emergency Exit

Root Room

Blazing Star

Big Bluestem

Fungal Hyphae

Prairie Clover

Root Room Post
Field Guide
No Rest
Cob Webs
Sign

Habitats

Habitat Post
Creature Comforts

Root Tip Unit
Root Tip
Your Task label
ID label

Soil Crumb Unit
Soil Crumb
Your Task label
ID label

Centipede Unit
Centipede and grub from window
Your Task label
Centipede and grub from walkway

Movement

Movement Post
On the Move
Your task

Easy root

Day1/Day2

Mole Cricket Unit
Mole Cricket
Label

Mole Tracking Station
Video
Label
Your Task

Movement Video (Touch Screen)

Soil Nursery

Seed Area

Soil Nursery Post
Babies
Shhhh

Seed Nursery
Pea
Bluestem
Oak
Clover
Blazing Star

Fungus Room

Seed Unit
Seed
Your Task label

Fungus Maker Unit
Flips
Label
Your Task label
Pix

Snail Unit
Snail
Label

Earwig Area

Wall Unit
Viewing windows
Your Task Label
Mole Label
Mole Photo (Mammals Nest Picture)

Earwig Unit
Earwig
Caution Label

Cicada Area

Cicada Post
Measure
Lifecycle
Your Task Label
Cicada Wheel

Cicada Room
Mural
Exoskeletons

Air & Water

Air & Water Post
Good Earth Label
Stretch into Soil Space A
Stretch into Soil Space B

Soil Space
Stretch into Soil Space Interactive
Water Wall & Well

Crayfish Area

Crayfish Unit
Crayfish
Viewing Holes

Crayfish Post
Crayfish Label

Food Chains

Food Chain Post
Recycling Label

Food Area

Vending Machine
Bug Label
Foil Wrap

Picnic Table

Viewing Windows (Root View)

Hot Spot Map

Your Task

Root Rot Area

Root Rot Unit
Critters
Who's Who Label
Hot Spot Label

Ants

Connections Post
Barrier Label
Mixing Things Label

Ants

Fungi

Foxfire fungi

Fungi Post
Connections Label
Your Task Label
Ectomychorrhizal Label

Spider
Wolf Spider
Wolf Spider Label

Rhizobia

Acorn

Rhizobia Post
Up/Down Label
Relationships Label

Exit
Micro Strobe
Micro Strobe Label
To Mud Room Sign

MR – Mud Room

Measure Wall
Mirror
Text

What's What
Good Label Label
Good Label Comic
HTR Flips
Help The Researcher Label

Take a Closer Look
Left Label

Shoe Box
Right Label
Crayfish Case
Magnifying Glass #1
Flip Book #1
Mole Case
Mole Case Label
Magnifying Glass #2
Flip Book #2

Digging Around
Backyard Label
Backyard Case
Oak Forest Label
Oak Forest Case
Sand Dune Label
Sand Dune Case
Marsh Label
Marsh Case

Saving Soil
Saving Soil Label
Losing Soil Label
Losing Soil Flip Book

Making Soil
Making Soil Timer
Making Soil Case
Making Soil Text

Prairie Profile
Horizon Side
Sideways Side

Challenges Computers
Saving Our Soil Label
Saving Our Soil #1
Saving Our Soil #2
Saving Our Soil #3
Saving Our Soil #4
Saving Our Soil Slave Monitor

Trickle Down
Trickle Down Label
Soil Particles Label
Percolator
To Do Label
Dish of Soil
Coming Up For Air Label

Big Bluestem
Plant
Label

Rambling Roots (Pull A Plant)
Rope
Label Left
Plants
How To Label

Fertile Farmlands
Label Left
Button
Title

Recycling
Title
Label Left
Button
Working With Soil Label

Soil Structure
Label
Flips

Altered Soil
Panel

Nutrient Cycle
Label Right
Wheel
Label Flat
Nutrient

Interactive

Balanced Diet
Main Label
Plant #1
Plant #2
Plant #3
Plant #4
Plant #5
Flat Label
Right Label

Dirty Job
Main Label
Legos
Flips
Left Label
Flat Label

Swallow Cliff
Scientists Label
Outdoor Lab
Native Oak Species
Early Reports Label
Cliff Notes Left Label
Cliff Notes Right Label

CN – Connections

Introduction
Intro Panel Left
Intro Panel Right

China
Couple
Case Labels
Case Objects
Map of China

Urban
Soul Man
Small Label
Vegetable Case
Garbage Label
Map of US

Medicine
Potatoes
Allen
Case
Allen Labels

Archaeology
Paul
Paul Label
Case
Case Labels
Maps

Peru
Couple
Tools
Case Label
Map
Couple Label

Bench
Rice Cutter
Chert Hoe
Kachina

Drum Case
Cicada
Dung Beetle

Toy Farming
Case

TH – Theatre

Benches

Video Clips

CL – Conclusions

What Is Soil?

Questions
Answers

Quotes

Kaleidoscope

Kaleidoscope
Label Left
Label Right

Appendix B: Overview of Depth Observations

Depth Observations for *Underground Adventure*

date	respondent(s)	contact hrs	# of resp.	# adults	# children	females	males	data coll.
30-Mar-00	033001	1.5	3	1	2		3	CG
31-Mar-00	033101	2.0	2	1	1	1	1	DP
4-Apr-00	040401	2.5	2	1	1	2		DP
29-Apr-00	042901	3.0	2	2		2		CG
5-May-00	050501	1.5	1	1		1		DP
9-May-00	050901	1.5	2	1	1	2		CG
8-Jun-00	060801	0.75	1	1		1		DP
13-Jun-00	061301	0.75	2	1	1	1	1	CG
TOTAL		13.5	15	9	6	10	5	

Total number of depth observations = 8

033001: Two boys, ages three and five, with their father, in his 40s. This visit was their fourth time to *Underground Adventure*. The father, an avid museum-goer, has worked in and with museums most of his life. The two boys are interested in things scientific, including dinosaurs, bugs, and cars.

033101: Teenager and his mother. At the time of this study, the teen was in the tenth grade and about 15 years old. The data collector noted that he seemed very smart, quick, funny, and articulate. He was affectionate with his mom, and they seemed to have a close relationship, bantering back and forth every now and then, and wanting to share stuff with each other. The mother, who was in her 40s, had heard about the exhibition, but had never seen it before this visit. At the time of this observation, she was pursuing a degree in early childhood development and had worked in children's museums for many years. She had also participated in a number of museum research and evaluation studies.

040401: Mother and daughter. The daughter was in the third grade and was bright, active, enthusiastic, and very articulate. She was an only child with a close relationship with her mom. During the school year, the daughter had participated in an after-school Earth Savers Club. The daughter had never seen the exhibition before, but had heard her mom talk about it briefly. The mother, in her 40s, is a

museum professional who had quickly visited the exhibition once before.

042901: Two adult women, both in their early thirties. At the time of this study, one was a graduate student in design and an avid gardener. The other worked for a technology company and had a strong interest in environmental issues. This visit was their first to *Underground Adventure*.

050501: An adult woman in her 40s who lives in a rural location in the northern woods of Maine. She is a respiratory therapist who works at the local hospital. A long-time vegetarian, she grows much of her own food, using organic farming techniques. She goes to museums when possible, but is not an avid museum-goer, preferring to spend time outside. A lover of science, astronomy, and anthropology, she earned her bachelor's degree later in life. She has been to the Field Museum three or four times previously, but this was her first visit to *Underground Adventure*.

050901: An eight-year-old girl and her adult cousin, in her 20s. The girl had been to the Field Museum before, but not to *Underground Adventure*. Her cousin had purposely not told her about the exhibit before this visit. The adult woman has experience in visitor studies and museum evaluations. She was also pursuing a master's degree in economics at the time of this study.

060801: An adult woman in her 40s who is an associate professor at a large Midwestern land-grant university. A lover of art and literature, she has a slight disdain for science and things scientific. She teaches qualitative research in the Education Department and has written a book on feminist research methodologies. A frequent museum-goer, she had little desire to go *Underground Adventure* because of her lack of interest in science and her dislike of bugs and spiders. This visit was her first to the exhibition.

061301: A three-and-a-half-year-old boy and his mother, in her 20s. The boy had recently become interested in bugs. He had been to the Field Museum a few times, but not to *Underground Adventure*. As an experiment, the boy was "prepped" before his visit. The data collector told him that at the exhibition, they were going to pretend to shrink smaller than the bugs. She told him they would go underground and see what was there, including bugs that were really big. She reminded him that it was just "pretend." His mother was a museum professional. We were more interested in her interactions with her child than her own reactions to the exhibit.

Appendix C: Debrief Example

Underground Adventure
Observation
052501
Cecilia Garibay

Visitor Group: This was an extended family consisting of the following: 1 teen girl about 15, 1 young boy about 5 years old, three women, approximately 2 in their 30's and one in her 50s, and 1 man in his 30s. One of the women and the man seemed to be the young boy's parents. The older woman appeared to be his grandma.

women only
Total time: 22 minutes
Time at video section: 1 minute
Time in Underground Experience: 12 minutes
Time in Mud Room: 4 minutes

man and boy
Total time: 27 minutes
Time at video section: 2 minutes
Time in Underground Experience: 12 minutes
Time in Mud Room: 9 minutes

Visit

This group skipped the advance organizer and moved straight to the video area. It was pretty quiet. They watched the video for about a minute and then went in. As they were going through the Shrink Chamber, several of the adults directed their attention to the young boy and reminded him that they were shrinking. They all seemed to be having a good time. They were laughing and smiling as they went through it. They went underground and they all focused on the penny. They moved along the exhibit, reminding the boy that they were small and underground. They focused on the beetle grub. The dad touched it and one of the women told the boy that if they [the visitors] were big [meaning actual size] they wouldn't be able to see the beetle. The boy looked at the grub but didn't say much.

They moved on to the spoon of soil. The older woman asked, "what are those fireflies?" It was crowded at this point so they didn't read any labels. They looked confused but I wasn't able to hear if they were saying anything because there was a loud group coming in. Next, they walked by and got to the root section (near the emergency exit). They pointed out the roots to the boy. Of the women said, "that's what the roots look like underground." The man spotted the mole cricket and they went over there. At this point the boy got scared and his dad picked him up and held him. His dad backed away a bit to make the kid more comfortable. They didn't say much about it other than to tell the boy that it was a mole cricket. Because the boy was afraid, they moved along. As they were doing that, one of the women said, "he's not going to get you." I also overheard two of the women talking with each other about the boy. One said he was afraid of it and the other, after the kid had moved away, said that the kids would look at it as long as it was at a distance.

They moved on to the soil nursery and looked at the plants. Two of the women quickly looked at the labels. It seemed to me that they were trying to find out more about what these seeds were. They didn't say much other than to comment that

these were seeds.

The group slowly moved to the area with the fungus makers but never actually stopped. They seemed to be looking for something to catch their attention. The man in the group spotted the viewing windows to the earwig and looked through. In the meantime, the rest of the group had made their way to the earwig and stood there looking at it. The man joined them and they stood there. Again, they directed their attention at the little boy. One of the women told him it was an earwig and pointed out the eggs and "babies." At that point the animatronic started to move. The boy was visibly scared and started backing away. His dad held him. One of the women commented that she was being a "protective mother."

They decided to move on and went to the cicada room. I didn't hear any conversation about cicadas or bugs that shed their shells. Instead, it became more of an area for fantasy play. They gathered around the exoskeletons and had the boy climb in, telling him he could pretend to be a bug. He seemed to really enjoy this. He was small enough to curl up in the skeleton and did so. He really seemed to enjoy that.

Next, they moved on to the area with the crayfish. What caught their attention initially was the wall opposite from the crayfish. The dad pointed out one of the water drops to the kid and other members of the group looked more carefully at the wall. They noticed other water drops there. The man explained to the child that this was a big water drop and that water seeps into the dirt. By that time, several members of the group had turned their attention to the crayfish. One of the women looked at the sign to see what it was and told the group it was a crayfish. A couple of the women noticed the viewing window on the floor and looked through but they did not say anything about it. The group (including the boy and dad) looked at the crayfish together. They talked briefly about how big it was and then moved on.

They got to the vending machine and one of the women read what was in each of the "packages." The other woman said, "I don't think so," indicating, I think, that she had no desire to have any of that. Meanwhile, a few members of the group made their way to the viewing windows for the root rot. They peeked in quickly and decided to go around the corner to look at it. They gathered around, and one of the women commented that it was moving, but that was the extent of conversation about it. They quickly moved on and it didn't look like any of them read either of the labels.

Next, they peeked in at the ants. They boy was in front, but the dad was holding on to him. One of the women (I think the boy's mom), pointed out each of the ants and what they were doing. The other folks in the group looked around but it didn't look like they were focusing on anything in particular. The group made their way to the spider. They stayed there for a bit looking at it. One of them told the child that the spider was eating a worm. Another said to him, "look how big he is compared to us." [I guess meaning that he was bigger than in real life.] During this whole time, the kid didn't seem especially thrilled to be there and he kept his distance. As they were leaving, he said that he didn't like spiders.

They moved on to the Mud Room. The group split up at this point. The group scattered a little but mostly looked around. I followed two women with the boy. They went to the display on tools scientists use to study soil. The boy was very intrigued by the bugs in that section. He asked, "Did we see those bugs?" [meaning in the Underground Experience]. One of the women said, "probably." They didn't say anything else but they all looked at the bugs. The boy seemed pretty focused on

them, which was nice to see! At this point, they went back to the wall where visitors can measure themselves because most of the other folks in their group, except the man, had gathered there. Each one measured herself and then they had some discussion about who was taller and whether so and so was taller than her respective mother. This led to a discussion about height in their family. By now, the dad had come back and met up with the boy. I decided to focus more attention on the boy and dad at this point who seemed a bit more involved in the exhibit. They went to the soil tools again. The dad looked at the display with the wheelbarrows of dirt. He said, "look at this dirt. This must be some sort of special dirt." [Probably because it was on display behind glass?] At this point, the boy said that he wanted to go back and "be little again." The dad seemed to ignore the comment and instead, they went to the Seasons section. The dad helped the boy do each one, carefully pointing out the different seasons as the mushroom, toad, etc. changed.

By now the women had dispersed. They all met up at the display cases around the column ("Digging Around"). They spent time carefully looking at the different specimens. Sometimes they'd point out some specimens to one another. The dad and mom, in particular, spent time with the boy and pointed out different animals to him. The boy said again that he wanted to go back and "be little again." One of the women wondered out loud if they could do that. They decided that they probably couldn't. Instead, the boy and dad went to the computer. I tried to follow them but they went to a computer against the wall where no one else was around. I decided it would have looked too obvious for me to stand around trying to listen to their conversation. So, I followed the women instead. By this time they seemed a little bored. They wandered around leisurely without looking at anything in particular. They came to the decomposer interactive, glanced at it and walked out. They waited right at the exit to the Mud Room and talked about other [non-exhibit] stuff. I then went back to see if I could catch up with the boy and man. I realized that they hadn't spent much time at the computers, because I spotted them at the mole interactive. The boy turned the crank and watched the yellow ball. The dad didn't say anything. They went over to the tractor interactive next. It seemed to me that the dad couldn't figure out what to say. They stood there for a couple of seconds looking at the interactive and then left. They met the rest of their group and they went to the sphere. They looked at it briefly and then went into the gift shop. I waited around until they finished shopping to interview them but they declined, saying they didn't have much time left at the museum.

Interactions
Here are my ratings:
PI – 2
S – 2
I – 2

Reflections
This was a really interesting group. I wish that I had been able to interview them.

1. I was very surprised that the kid wanted to go back to the Underground Experience. He was clearly scared at different points in the Underground Experience, yet something intrigued him enough that he wanted to go back. I think this suggests that there is a "good" kind of scary that some kids enjoy.

2. It's become clearer to me that parents with younger children have a hard time talking to their kids about what is going on. In the Underground Experience, they primarily point out the big bugs and occasionally the roots, etc. However, I don't think they have the information to do much more than identify the

bugs. Maybe that's okay with families with small kids. At the Mud Room, the biggest attraction does seem to be the actual specimen cases.

3. I was encouraged by the boy's question as to whether the bugs in the cases were ones he had seen in the Underground Experience. That tells me that on some level, the Underground Experience had piqued his curiosity. Maybe seeing that they were really small creatures reassured him and on some level he though it would be okay to go back to the Underground Experience. I also think that folks probably want to see the comparison between what they saw in the Underground Experience and what the real bugs look like. The staff has done some of this. For example, they have a crayfish in the display cases and they point it out. They need to do more of this or at least be more obvious about it. I'm not sure if they actually have all the creatures on display at the Mud Room that are highlighted in the Underground Experience. But, maybe there needs to be a case that has all of them very clearly marked.

4. Overall, I think this group had a good time but they didn't especially spend a lot of focused time in the exhibit. It was interesting to see how much they focused on the kid and his experience. I wonder if it was their impression that the exhibit was a "kid" kind of experience.

5. I was pretty disappointed that I waited around for this group and then didn't get to interview them. I would like to have heard what they came away with. My sense is that I would have gotten that there are a lot of bugs in the soil, or something to that effect.

6. I am concerned about how slow the data collection process is going. So much of it depends on how long visitors stay, and the writeup is very time consuming. What concerns me though is that even after following a visitor group, there's no guarantee that they will agree to an interview. That can waste time and seems to mean that we can interview fewer folks this way.

Appendix D: Observations and Interviews

Unobtrusive Observations and Depth Interviews for *Underground Adventure*

date	#	contact in min.	# adults	# children	females	males	observation	interview	data coll.
25-Apr-00	04 25 01	60	2	2	3	1	1	1	CG
26-Apr-00	04 26 01	10	1	1	1	1	1		CG
	04 26 02	90	1	1	1	1	1	1	CG
	04 26 03	15	4	2	4	2	1		CG
28-Apr-00	04 28 01	45	1	1	1	1	1	1	CG
	04 28 02	15	3	4	6	1	1		CG
17-May-00	05 17 01	5	2	1	1	2	1		LD
	05 17 02	25	1	1	1	1	1	1	LD
	05 17 03	45	3	2	5	0	1		LD
	05 17 04	35	3	0	2	1	1		LD
18-May-00	05 18 01	22	3	1	2	2	1	1	LD
	05 18 02	30	5	0	0	5	1		LD
	05 18 03	39	2	0	2	0	1	1	LD
20-May-00	05 20 01	54	2	3	3	2	1		LD
22-May-00	05 22 01	26	4	0	2	2	1	1	LD
	05 22 02	44	1	0	0	1	1	1	LD
25-May-00	05 25 01	27	4	2	4	2	1		CG
	05 25 02	20	2	0	0	2	1		CG
7-Jun-00	06 07 01	11	1	1	2	0	1		LD
	06 07 02	30	1	1	0	2	1	1	CG
	06 07 03	45	1	1	1	1	1		LD
	06 07 04	55	2	2	1	3	1	1	CG
14-Jun-00	06 14 01	15	2	2	2	2	1		CG
	06 14 02	34	1	4	3	2	1		LD
	06 14 03	29	1	1	0	2	1		CG
	06 14 04	66	4	0	4	0	1	1	LD
15-Jun-00	06 15 01	95	2	2	3	1		1	LD
16-Jun-00	06 16 01	10	2	0	1	1		1	DP & LB
	06 16 02	10	1	1	2	0		1	DP & LB
	06 16 03	20	1	1	2	0		1	DP & LB
17-Jun-00	06 17 01	40	1	1	0	2		1	LD
19-Jun-00	06 19 01	15	1	2	1	2	1	1	CG
	06 19 02	15	1	3	2	2		1	CG
20-Jun-00	06 20 01	44	2	0	1	1	1		LD
	06 20 02	37	2	0	2	0	1		LD
TOTAL		1178	70	43	65	48	29	18	

Total number of:
respondents = 113
adults = 70
children = 43
females = 65
males = 48

observations = 29
observations followed by interviews = 12
observations with no interviews = 17

interviews = 18
interviews with no observation = 6
interviews preceded by observation = 12

interviews and/or observations = 35

Contact Hours = 1178 minutes/60
= 19.6 hours

Appendix E: Topical Framework

Topical Framework February 29, 2000

A. Communication of Messages
   1) How well does the exhibition communicate the main messages? What other types of messages are visitors taking home? To what extent and in what ways are different types of visitors taking home different messages?

   2) To what extent and in what ways is the exhibition contributing to visitors' attitudes about soil and soil organisms, both positively and negatively?

   3) How effective is the exhibition at helping visitors overcome misconceptions? What, if any, misconceptions is the exhibition perpetuating?

   4) What kinds of conservation messages is the exhibition most effective at communicating? Which ones is it less effective at communicating?

B. Atmosphere
   1) To what extent and in what ways is the exhibition comfortable or uncomfortable for visitors? How do they describe the ambiance of the exhibition as a whole?
      a.) Are the light levels adequate?
      b.) Is the length of the exhibition appropriate?
      c.) Is the wayfinding effective?
      d.) Do visitors get easily fatigued?

   2) How does the immersion experience make visitors feel? Does it seem real or contrived? Do visitors feel claustrophobic? Creepy?

   3) How does the mud room experience make visitors feel?

C. Enjoyment and Satisfaction
   1) To what extent and in what ways do visitors feel satisfied with their experience in Underground Adventure? What kinds of words do they use to describe their experience? Do they feel there is an appropriate balance of "learning" and "fun"?
   2) How successful do visitors feel at understanding the exhibit's

content? In what ways do they feel frustrated? In what ways do they feel bored or uninterested?

3) What questions does—and doesn't—the exhibition answer for visitors?

4) To what extent and in what ways are visitors being playful and having fun?

5) To what extent and in what ways does the exhibition pique visitors' curiosity about something they weren't interested in before?

D. Use of Exhibition Space and Elements

1) Overall Exhibition
   a.) How much time do visitors spend in the entire exhibition?
   b.) Which elements are visitors using most frequently? How are they using them?
   c.) Which elements are visitors not using very much? How are they using them?
   d.) To what extent are visitors using the exhibition the way the development team intended?

2) Base Camp
   a.) How long are visitors spending in the Base Camp?
   b.) How do visitors use the Base Camp? To what extent does it prepare them for the rest of the exhibition?

3) Underground Experience
   a.) How long are visitors spending in the Underground Experience?
   b.) How do visitors use the Underground Experience?

4) Mud Room
   a.) How long are visitors spending in the Mud Room?
   b.) How do visitors use the Mud Room?

5) Theatre
   a.) How long are visitors spending in the Theatre?
   b.) How do visitors use the Theatre?
   c.) Why do visitors choose to use it or not use it?

6) Challenges Computer Stations
   a.) How long do visitors spend at the Computer Stations?
   b.) How do they use them?
   c.) Which of the programs are they choosing to use/not use?
   d.) After spending time with the computers, what messages or misconceptions are they taking away?

E. Social Interaction
   1) How do visitor groups use the exhibition? Do they tend to stay together or do they tend to separate?

   2) What kinds of interactions are occurring between parents/caregivers and children?

   3) What kinds of conversations are visitors engaging in?

   4) To what extent and in what ways are visitors talking about the main messages of the exhibition?

   5) To what extent and in what ways is teaching/learning behavior taking place? Are visitors directing attention? Reading labels out loud? Working among themselves to make sense out of the exhibition? Explaining the exhibition concepts at an age/experience-appropriate level? Engaging in meaningful questioning/answering behavior?

Appendix F: Research Questions

Underground Adventure Research Questions
Deborah Perry
Selinda Research Associates
March 30, 2000

Overall Satisfaction:
[Feeling good about their experience.]
To what extent and in what ways do visitors feel satisfied with their experience? Was there the appropriate balance of outcomes, engagement, and enjoyment? Was there a minimum of frustration, intimidation, and discomfort?

Knowledge:
[Developing a deeper or more sophisticated understanding about something.]

1. To what extent and in what ways does this exhibition help visitors evolve their understanding about soil? Life in the soil? About biodiversity? What about the importance of soil to the health of the planet?
2. How do they describe what the exhibit is about? What do they think the main idea is?
3. To what extent are the museum's intended messages getting across?
4. Which of the museum's intended messages are getting across to the greatest degree?
5. What misconceptions and incomplete understandings are the exhibition reinforcing?
6. Where is mis-learning happening?
7. What are the different meanings that visitors are creating? What things are they getting smarter about? What things are they *not* getting smarter about?

Interest:
[Creating a new interest in something or extending an existing interest.]

1. What are visitors more interested in as a result of participating in this exhibition?
2. To what extent and in what ways does the exhibit pique visitors' curiosities about life in the soil? About soil's role in the world ecosystem? About the biodiversity of life in the soil?

Appreciation:
[Developing a deeper appreciation for something.]
1. To what extent and in which ways does this exhibition appear to change visitors' attitudes?
2. What messages are visitors taking away? What do visitors think the main message of the exhibition is?
3. What issues or things are they developing a greater appreciation for?
4. What attitudes does the exhibit appear to shape? In what ways?
5. In what ways is the exhibition reinforcing pre-existing attitudes about soil and dirt? Is this good? OK? Bad?

Skills:
[Learning how to do something new, or getting better at doing something they already knew how to do.]
1. To what extent and in what ways is this exhibition helping the visitor develop scientific thinking skills?
2. What other skills is it helping visitors develop?
3. To what extent and in what ways is it inhibiting learning new skills?

Physical Engagement:
[All the various ways—intended and unintended—that visitors use the exhibition; all the things they do while in this particular environment.]
1. How long do visitors spend in the exhibition as a whole?
2. How long do they spend in each of the six major sections (base camp, underground experience, mud room, connections, the computer stations, and conclusions)?
3. Which are the most visited exhibit units? Which are the least visited? Why?
4. What is the nature of their physical interactions in each of the six major areas? What do visitors do differently in the six different areas? How is their behavior and what they do different?
5. What is the range of ways that visitors use each of the six major areas? How can we characterize what visitors do in each of the six areas?
6. What is the range of things visitors do in the exhibition as a whole? How can we describe the various things visitors do and the ways they behave in the exhibition?

Social Engagement:
[All of the various ways visitors talk and engage with each other while in the exhibition.]
1. What is the range of ways visitors engage socially while in this exhibition? To what extent is this social interaction of a type that

maximizes the potential for learning to occur?
2. How can we characterize the different ways that visitors socially interact in the exhibition?
3. How is the social interaction that visitors engage in qualitatively different in each of the six areas?
4. What is the range of ways that visitors talk about things while they are in this exhibition? What things do they talk about?
5. To what extent and in what ways is the social interaction in this exhibition enhancing and/or inhibiting learning? To what extent are visitors engaged in teaching/learning behaviors and group problem-solving?
6. To what extent and in what ways do visitors engage in the "amoeba phenomenon?"
7. To what extent and in what ways do visitors work together to create meaning in the exhibition?
8. To what extent and in what ways do visitors share new revelations?

Intellectual Engagement:
[All of the various ways visitors are thoughtful and reflective while in this exhibition.]
1. To what extent and in what ways are visitors thinking about the content of the exhibition? What other things are they thinking about?
2. What is the nature of the individual or personal experience for visitors?
3. What is the range of ways that visitors think about the exhibition? How much of this is related to the educational content? How much is not?
4. What else are they thinking about?
5. How are the way they think and what they think about qualitatively different in the six different major sections?
6. To what extent and in what ways do intellectual and thoughtful engagement in this exhibition enhance and/or inhibit learning?

Emotional Engagement:
[All of the ways visitors experience the exhibition in an emotional way.]
1. What is the range of emotional experiences for visitors to this exhibition?
2. How are these qualitatively different in different areas? At different exhibit units?
3. In what ways and to what extent do visitors' emotional engagements inhibit and/or enhance learning?
4. In what ways and to what extent do visitors experience fear, awe,

fascination, and/or skepticism? What other emotions do they experience?

Having Fun:

1. To what extent and in what ways do visitors enjoy themselves in this exhibition?
2. What is the range of enjoyable experiences visitors have while in this exhibition?
3. To what extent and in what ways do these enjoyable experiences enhance and/or inhibit learning?

Curiosity:

In what ways and to what extent:

a.) Are visitors surprised and intrigued?
b.) Is the visitor's attention attracted?
c.) Is intellectual curiosity stimulated?
d.) Is the exhibit interesting to visitors?
e.) Do visitors relate what they are experiencing to other things with which they are familiar?
f.) Do visitors make the exhibit personally meaningful?
g.) Do visitors perceive that this exhibit presents new ideas in a new way?
h.) Do visitors perceive that this exhibit contradicts something they knew before?

Confidence:

In what ways and to what extent:

a.) Does the visitor feel successful?
b.) Do visitors perceive that they will able to succeed?
c.) Is the visitor able to succeed immediately?
d.) Is the exhibit easy for visitors to understand?
e.) Does the visitor feel overwhelmed and/or intimidated?
f.) Are all members of the visitor group engaged?
g.) Are the visitors' questions answered?
h.) Does the visitor feel bored?
i.) Do visitors feel at home and physically comfortable in the exhibition?
j.) Does the visitor successfully complete the intended activities?
k.) Do visitors feel frustrated because their questions aren't adequately answered, or the exhibit is not working, or they can't figure something out?

Challenge:

In what ways and to what extent does the visitor:

a.) Know what to expect?

b.) Readily perceive what the goal of the exhibit is?
c.) Understand what they are supposed to do?
d.) Pay attention to the important parts of the exhibition?
e.) Feel challenged, i.e. that they will have to do something to achieve success?
f.) Perceive that there is something to be learned?

Control:
In what ways and to what extent:
a.) Does the visitor feel that they have choices?
b.) Does the visitor feel overwhelmed by those choices?
c.) Does the visitor experience powerful and/or meaningful effects from their actions?
d.) Does one visitor's control inhibit or detract from the quality of experience for other visitors?

Play:
In what ways and to what extent:
a.) Are visitors playful?
b.) Do visitors engage in fantasy play?
c.) Do they take the shrinking seriously? Who does this work the best for?
d.) Do visitors use their imaginations in other ways?
e.) Do visitors enjoy the exhibit via sight? Smell? Touch? Sound? Taste?

Communication:
In what ways and to what extent do visitors:
a.) Feel that they are part of a successful communication exchange?
b.) Work together on activities?
c.) Engage in a thoughtful and systematic teaching/learning process?