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Finding Significance was a deeply collaborative project throughout its four years of existence. It came into being as the result of conversations between myself and Co-Principal Investigator, Kathleen McLean—she had long wanted to experiment with personal narratives on our museum floor, and I was interested in studying visitor meaning-making at exhibits. The synergy was immediate and inspirational, and Kathy’s broad experience, insights, and dedication to excellence guided and energized the team whenever we lost our way.

Other members of the team were equally rewarding to work with: Joshua Gutwill contributed his enthusiasm and acuity to all aspects of the research, especially the quantitative analyses; Noah Feinstein created the most thoughtful and meticulous coding rubrics I have ever seen; research staff Veronica Garcia-Luis, Nina Hido, and Steve Tokar trained and led an outstanding group of data collectors and coders (in particular, I’d like to mention Richard Bressani, Suzanne Buennagel, Alyssa Freedman, Emily Hatch, Mary Kidwell, Adam Klinger, Gabriele Phillips, Jennifer Rose, Molly Tascone, and Jacqueline Wong); Theodore Koterwas deeply embraced our research perspective without ever losing his commitment to developing high-quality multimedia experiences for visitors; Elisabeth Spencer brought her creativity and thoughtfulness as a video producer and filmmaker to the project; Dia Felix gracefully and efficiently oversaw most aspects of the video production and post-production; Curtis designed and built the complex housing for the video kiosk; and project managers Gretchen Sanderson, Alice Krasinski, Chad Perry, and Jessica Ruskin kept us on track during different stages of the project and held it all together with a great blend of strategic thinking, realism, and compassion.

The team was fortunate to have a talented group of advisors who helped us refine our research design and constructively critiqued our ideas: Larry Bell, Minda Borun, Gordon Chun, Lynn Dierking, Lorraine Garcia-Nakata, Don Hughes, Randi Korn, Deborah Perry, Barbara Rogoff, Michael Spock, and Barbara White. George Hein, research consultant to the project, gave us incisive comments and liberal doses of encouragement from inception to final publication.

We learned a great deal from our conversations with experts on narrative and storytelling, including Larry Adelman, Joel Ben Izzy, Michelle Carter, Tim Ereneta, Randall Fastabend, Diane Ferlatte, Jona Frank, Ira Glass, Catherine Hughes, Laura Martin, Paul Martin, Judy Rand, Lisa Roberts, Farhad (Fred) Saba, Roger Shank, and Naomi Torres. Their insights will remain with us well beyond the project’s conclusion. We also gratefully acknowledge the contributions of the actors we worked with, including Atosa Babaoff, Karen Hager, Anthony Haynes, Shannon Johnson, David Smith, Derek Yee, and Bruce Pachtman (who also directed some of the shoots).
Many scientists, artists, and Exploratorium staff agreed to be interviewed during various phases of the work and told their personal stories with honesty and good humor. Other Exploratorium staff helped the project move forward in ways too numerous to mention here, and they are deeply appreciated.

Many people helped to make this publication a reality. Kathleen McLean, Noah Feinstein, Dia Felix, Joshua Gutwill, Theodore Koterwas, and Hugh McDonald all contributed insightful writing for various sections; statistics consultant Linda Long worked with us through some tricky analyses with flexibility and grace; Hugh McDonald gave far more intellectual support than his title of editor implies; Jessica Brainard and Olimpia Cerdá provided editorial and graphics support; and Mark McGowan designed the publication and made it both beautiful and accessible.

Ultimately, this project was for the benefit of the people who use museum exhibits—the visitors. We worked with many of them during the course of the project, and their time, energy, and openness made the research come alive.

Finally, we gratefully acknowledge the Informal Science Education (ISE) Program of the National Science Foundation for its generous support.

Sue Allen
Director of Visitor Research and Evaluation
Exploratorium
Introduction

Wander through the Exploratorium on a Free Day in the spring, crowded with people of all ages and from all walks of life, and you will see evidence of the power of an experience-driven philosophy of education. People interact energetically with the exhibits, pressing buttons and pulling levers, and talk excitedly as they move from one active element to another. But it’s not until you work at the Exploratorium—until you are immersed in the behind-the-scenes conversations with exhibit developers, scientists, artists, and the mix of creative and quirky individuals who actually make the museum—that you really experience the engaging pedagogy and ideas of the place, and the depth and breadth of the science and art behind the exhibits.

In watching visitors’ dynamic and animated interactions with exhibits, staff often assume that visitors’ experiences are as generative, reflective, and inquiry-driven as the staff’s. But when exhibit developers and evaluators talk systematically to visitors, we find that, in many cases, visitors are not having the depth of experiences that staff hope for and are not making the kinds of connections staff expect. Visitors repeatedly tell us they enjoy the exhibits and think they are “cool” and “fun,” and some think that the exhibits are great gizmos for kids. But many people don’t perceive clear connections among exhibits, or relate their exhibit experiences to the rest of their lives or the world beyond the walls of the Exploratorium. Clearly, there is still much to learn about exhibit design supportive of deeper visitor experiences.

One of my main interests in joining the staff of the Exploratorium was to extend the experimental nature of the organization to include visitor research on the exhibits. The Finding Significance project grew from conversations about how we might take the richness of the behind-the-scenes interactions and explorations of staff—filled with stories about initial inspirations, the beauty of phenomena revealed, how and why exhibits are built, what individual developers, artists, and scientists experience at the exhibits—and share these stories, observations, and questions with visitors out on the exhibit floor. We had a hunch that providing multiple perspectives and modeling the inquiry process might help visitors find more diverse points of access to exhibits, possibly stimulating curiosity and enhancing understanding. And we hoped to learn more about the roles of narrative and inquiry in enhancing personal meaning-making.

The concern for visitor meaning-making is not new to museum professionals; even 17th-century notions of museums as places of “public instruction” provoked considerations of visitor learning. But it was not until the 1960s, with the increasing pressures of social democratization, that a palpable shift in museum education and exhibit practice began to take place. Recognizing the need to reach more diverse audiences and to provide greater museum access of all
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kinds—intellectual, cultural, social, and educational—museum practitioners began to experiment with new styles of exhibit presentation and interpretation and new ways of supporting visitor learning. Exhibit designers, developers, and educators increasingly realized that conventional methods of museum presentation, interpretation, and teaching were not adequate for a more diverse visitorship—that visitors had a wide variety of interests, starting points, comfort levels, and ways of understanding, many of which were not being addressed in traditional museum offerings. By the mid-1970s, a few forward-thinking exhibit designers and developers were beginning to employ newly emerging evaluation techniques in order to better understand how and what visitors learned at museum exhibits and programs.

Although museum practitioners, like classroom teachers, have a wealth of experience with real-life learning situations, they have rarely articulated their findings in a theoretical context, and their accumulated body of knowledge has only occasionally intersected with the field of formal educational research. Indeed, while the work of learning theorists like Piaget, Dewey, and Vygotsky has informed museum exhibition and education practices, much of the work of educational researchers has often seemed unrealistic or inapplicable to the real-life experiences of practitioners. Arguably one of the most powerful influences from the domain of educational research was Howard Gardner’s 1985 book *Frames of Mind*. Exhibit designers, developers, and educators embraced Gardner’s theory of “multiple intelligences” wholeheartedly, since it mapped seamlessly onto practitioners’ understanding of visitor behavior in museums. Concurrently, Bernice McCarthy’s work on learning styles added more support for the understanding that people learn in a diversity of ways. By the mid-1990s, Lois Silverman’s research on adult meaning-making, John Falk and Lynn Dierking’s research on the museum experience, and George Hein’s articulation of a “constructivist museum” helped practitioners to frame their work in more theoretical terms. Hein describes an experience-based constructivist model of learning that has stimulated a wide range of articles, conference sessions, and conversations among museum professionals, including Jay Rounds, Ted Ansbacher, Michael Spock, and others. But while the theory of constructivism has resonated with some exhibit practitioners, its practical applications make others uneasy: What are the roles of designers and interpreters, since visitors construct their own meanings? How much “construction” of the experience should practitioners take responsibility for, and how much room should be left for visitors to construct their own experiences? Today, the conversations continue as we grapple with design strategies for exhibits and programs that support truly meaningful visitor experiences.

When we started the *Finding Significance* project in 1999, the researchers, designers, and developers on the team were primed and ready. This was an exhibit research project at the intersection of theory and practice, combining the experiences and perspectives of exhibit practitioners and educational researchers to create an experiment that contributed to both domains. Theory and practice informed all aspects of the *Finding Significance* project, from conceptual design to final implementation and through all of the decision-making cycles and iterations that took place over the four years of experiments. This grounding was due, in great measure, to Sue Allen’s leadership and commitment to incorporating the expertise of exhibit designers and developers throughout this research project.

As communities, museum practitioners and researchers are farther apart than we often realize. What we need are more genuine ongoing partnerships.

*Alan Friedman (2003)*
The collaboration was exciting and rewarding for everyone on the team, but it was also frustrating at times. We struggled with an inherent tension between theory (the articulation of generalizable principles and methods) and practice (the design and implementation of unique experiences), which sometimes led to compromises between the rigor of the research on the one hand and the quality of the design and presentation on the other. There may be as much to learn from our process of working together as from the resulting data. Most importantly, we learned a great deal about each other’s domains. We all grappled with the rigor of the research design and the richness of the exhibit design. And together we worried about authentic visitor experiences and creative interpretive strategies.

In retrospect, I think it is very difficult—and perhaps imprudent—to retrofit fully designed and complete exhibits. It seems much more reasonable to put our energies into new exhibits designed specifically to offer multiple entry points and to model the process of inquiry. Today, as the project comes to a close with the writing of this book, we are left with some larger questions: Are there really generalizable ways to make exhibits more meaningful to our visitors, or is this a hit-or-miss proposition, more dependent upon the particulars of the situation, the creative vision of the designer, and the perceptiveness of visitors? How can we properly assess meaning-making in museums, and what is its relationship to learning? Are museum exhibits and programs appropriate media for providing deep, meaningful learning experiences, or should we be satisfied if they simply have the capacity to stimulate visitors’ curiosity and spark their imaginations? These are questions that cannot be answered by either research or exhibit development practice alone.

Only with more work by designers and researchers together will we learn how to create museum environments, exhibits, and programs that are deeply significant for visitors.

Kathleen McLean
Director of the Center for Public Exhibition and Public Programs
Exploratorium
In this chapter, we outline the theoretical foundations of the project and describe the key issues we wanted to address in the research.

Why Study Personal Significance and Meaning-making?

Learning in museums is not usually constrained by lack of information. More often, learners lack ways to create personal significance from the material being presented. Summarizing such research, Falk and Dierking (1992, p. 74) reported that “visitors try, often quite desperately, to relate what they are seeing to their own experiences,” and Hein (1998, p. 152) stated that “in order to facilitate learning...exhibitions need to provide intellectual and cultural 'hooks' that permit visitors to connect with the exhibitions.” The PISEC project (Borun & Dritzas, 1997) listed “relevance” as one of the seven characteristics of successful family exhibits, and recommended that exhibits provide cognitive links to visitors’ existing knowledge and experience.

At the Exploratorium, one of our greatest strengths has been providing intriguing and surprising hands-on experiences for our visitors, but we have not always given equal energy to helping visitors make sense of those experiences—either through deeply engaging with the ideas behind them or by finding something personally significant within them.

At the same time, many museum professionals are discussing constructivism, an educational philosophy that views learning not as the transmission of knowledge but as an active process of mental activity on the part of the learner (e.g., Hein, 1998; Jeffery-Clay, 1998; Osborne, 1998; Roschelle, 1995; Rounds, 1999). But the implications of constructivism for the design of exhibits and programs are controversial, and we still have much to learn about the qualities of exhibits that can enhance visitors’ abilities to find them personally meaningful or relevant to their lives beyond the museum (McLean, 2001; Roberts, 1997; Silverman, 1999). Through the Finding Significance project, we have tried to contribute to the field by exploring some ways to make existing exhibits more personally meaningful to visitors.

Project Goals

Finding Significance was primarily a research project. Our main goal was to compare different techniques of exhibit interpretation that have been used in museums to try to deepen and personalize visitors’ experiences. The techniques we chose fell into two main categories: “narrative” (personal storytelling) and “inquiry” (invitations to explore or think about an exhibit in greater depth). Specifically, we wanted to find out whether either of these techniques, if incorporated
into existing interactive science exhibits, could actually enhance visitors’ learning. Would they encourage visitors to think more deeply about our exhibits and the phenomena they illustrate? Would they help visitors to make more personal meaning from their experiences? Although we were interested in all aspects of learning, we were particularly interested in whether visitors would make connections between exhibits and their own lives, whether they would engage in more extended exploration of exhibit phenomena, and whether they might have new insights beyond what was already in the exhibit labels.

In order to study narrative and inquiry, we would first need to create examples of each. Therefore, our objective was to create the most compelling narrative- and inquiry-based exhibit enhancements possible, and then to conduct controlled experiments using them. As we describe in greater detail in later chapters, this objective would lead us through a series of alternating phases of development and experimentation (subject to various constraints), in the tradition of “design-based research” as described by Brown (1992).

Although we were determined to conduct the controlled experiments in the most unbiased way possible, most of our interest and energy during the project’s design phase was directed towards the creation of the narratives rather than the inquiries. This was a reflection of our eagerness to explore narrative as an underused technique in science centers, coupled with the recognition that creating powerful and effective narratives would be a major challenge for Exploratorium staff who had much more experience in developing inquiry-based experiences.

Visitors explore Meanderings, one of the Exploratorium’s many interactive exhibits.

**Theoretical Framework: A Learning Cycle**

In this project, we viewed learning as a cycle in which learners: 1) have experiences with exhibits; 2) find something in them that is relevant or significant (the “hooks”); and 3) integrate those experiences into their previous knowledge (which may include attitudes, beliefs, memories, etc.). Ideally, knowledge integration will lead to further thinking and questioning. 4) making the learner curious to have more experiences. This creates a cycle in which experiences alternate with processes of reflection or
Theory and Background

...attentive care must be devoted to the conditions which give each present experience a worthwhile meaning.

*John Dewey (1938)*

integration. Based on work by Dewey (1938), this learning cycle has been articulated in some form by many researchers and educators over the years, including Ansbacher (1999), Gunstone (1990), and White and Frederiksen (1998).

In this project, we think of “finding significance” as the process whereby visitors look for a place in their previous knowledge to integrate a new exhibit experience. If museums could help visitors make meaning from their experiences by suggesting multiple appropriate places in visitors’ prior knowledge where new experiences might fit, then visitors might integrate more of their experiences and move farther around the learning cycle.

**Technique 1: Narrative**

*Studying narrative in a science museum*

One technique we decided to study was narrative, or personal storytelling. For thousands of years before the written word, storytelling was the primary form of sharing knowledge over generations (e.g., Rubin, 1995). Studies have shown that narrative text is easier to both comprehend and remember than expository text (summarized in Graesser, Olde, & Klettke, 2002), although the reasons for this are still not fully understood. Narratives may work by engaging visitors in multiple levels of inference (Graesser et al., 2002), evoking emotions (Oatley, 2002), or setting the audience up to be potential participants in the unfolding

**A Simple Learning Cycle**

1. **Experience**
   (e.g., hands-on interaction with exhibit)

2. **Significance**
   (e.g., being reminded of something in your life)

3. **Integration with previous knowledge**
   (e.g., taking the time to feel or think about your exhibit experience; being changed in some way)

4. **Curiosity**
   (e.g., wondering what the exhibit will do if...)

...attentive care must be devoted to the conditions which give each present experience a worthwhile meaning.

*John Dewey (1938)*
Theory and Background

series of events (Polichak & Gerrig, 2002). In fact, some psychologists even go so far as to give narrative the status of a fundamental kind of human thought (Bruner, 1986) or the basis of intelligence (Shank, 1990).

The power of storytelling is widely accepted in historical and cultural museums, where it is routinely used in exhibits and programs to promote personal meaning-making by visitors (e.g., Bedford, 2001; Rounds, 2002). In the last decade, writers such as McLean (1993), Roberts (1997), and Silverman (1995) have further encouraged museums to use narrative—and particularly narrative with multiple voices—instead of presenting information to the public with a single voice of authority.

Narrative has also been used at the exhibition level in science centers and natural history museums (see, for example, Martin, 1996; McLean & McEver, 2004). At the Exploratorium, we had previously experimented with first-person narrative by incorporating staff stories into two audio tours (one for exhibits from our permanent collection and the other for the Turbulent Landscapes temporary exhibition), but we never had the opportunity to evaluate these systematically. Some museum professionals argue that understanding narrative is fundamentally different from scientific thinking (e.g., Graburn, 1977) and caution against making up stories to “sugarcoat” a scientific curriculum (Rounds, 2002). In this project, we wanted to rigorously assess whether narratives could bring the power and universality of storytelling to science center exhibits to see whether they might help to promote intellectual accessibility and personal meaning for visitors. Because this has been so rarely studied with phenomenological exhibits in science centers, we expected that the creation of powerful and effective stories for each exhibit might require significant time and energy during the design phases of the project.

We initially planned to include exhibit enhancements in which visitors were asked to tell their own stories rather than listen to those of others, but we rejected this option after pilot exploration because we found it so rare for visitors to have compelling exhibit-related stories to tell. Even Exploratorium members who were invited to tell stories about their favorite exhibits were unresponsive, and we realized that our research study might easily turn into a stressful performance situation for visitors if we insisted that they tell a story as part of using the exhibit. We therefore abandoned this line of experimentation and shifted our focus to staff stories, with visitors in the role of listeners. If visitors did take the opportunity to tell their own stories, we expected to hear about them when we interviewed visitors after their experience, at which time we could also find out about connections and associations they had made that might be less fully formed than a complete story.

Our working definition of “narrative”

According to literature professor H. Porter Abbott, a simple definition of narrative is “the representation of an event or a series of events.” Narrative is distinct from description: “My dog has fleas” is a description, while “My dog was bitten by a flea” is a narrative (2002, p.12). Abbott points out that others in the field have more stringent definitions of narrative requiring sequential or causally-related events. Of course, narratives are often far more complex than these bare definitions imply, with characters, settings, masterplots and subplots, conflicts, surprises, closures, themes, and narrators.

Jerome Bruner (1986)
Given the constraints of the project and our museum environment, we kept our definition of narrative quite loose so that we could explore a variety of kinds of narratives in the hopes of finding something that was effective for visitors. Broadly, though, we defined narrative as something that:

- took the form of a personal perspective spoken by a storyteller in the first person (“I”);
- involved a series of events;
- had emotional content, or at least relevance to human concerns;
- was fundamentally about the exhibit, not peripheral to it;
- was authentic in origin, in the sense that someone really told us the story; and
- did not explain the principles behind the exhibit.

(Throughout this publication, we use the terms “narrative” and “story” interchangeably, but indicate the specific enhancements we created with capitals: “Narrative.”)

**Narrative and meaning**

We expected the narrative enhancements to increase the exhibits’ significance for visitors in several ways. First, we thought that visitors might respond to the narratives at an interpersonal or emotional level because they would highlight the storytellers’ personal perspectives and emotional engagement. Abbott (2002) calls this response “narrative discourse,” or the way in which the story is told. Second, the storytellers would be modeling for visitors the act of personal meaning-making, so that visitors might feel encouraged to bring their own perspectives to the exhibit. Third, some of the specific associations and meanings the storyteller shared might be relevant to visitors as well, helping them make those same connections to their own lives. Fourth, we thought that narratives that came from staff members might help to bring visitors behind the scenes of the museum and let them share in the values and history of the people who made, repaired, and were inspired by these exhibits, and to bring a more human dimension to otherwise anonymous mechanical devices.

**Technique 2: Inquiry**

*Offering visitors suggestions for deeper exploration*

The second technique, which we called “inquiry,” was the use of direct questions to visitors—inviting them to explore or think about some aspect of an exhibit in depth.
Inquiry has historically been the guiding philosophy behind much of the Exploratorium’s exhibitory, and is also the focus of our Institute for Inquiry, an NSF-sponsored group that works actively with elementary school districts to develop powerful techniques for teaching science (Inquiry, 1998). Inquiry techniques are also relatively common at other science museums, including the Museum of Science, Boston (e.g., the Investigate exhibit collection) and the Science Museum of Minnesota (e.g., the Experiment Benches). Suggestions for exploring exhibits in depth often take the form of cards or booklets in a location secondary to the main label, so that visitors who have completed their initial interaction with the exhibit can select one or more cards if they want to investigate further.

To test the effectiveness of this inquiry-based approach, we created exhibit enhancements that invited visitors to try small activities not mentioned in the label or to imagine related situations and engage in thought experiments. We tried to create activities that were either reflective in and of themselves or that included a reflective component, so that visitors were investigating something meaningful with the exhibit rather than acting unconsciously. In this sense, we were hoping to encourage visitors to move repeatedly around the learning cycle, alternating experience with reflection.

Our definition of “inquiry”
In general, we defined inquiry as something that:

• was spoken directly to visitors, often addressing them as “you;”

• invited visitors to explore or think about the exhibit beyond what was in the label;

• was not personalized, in that it did not reveal anything personal about the speaker;

• was spoken in a “friendly teacher” tone;

• was usually phrased as a question; and

• was brief in comparison with narratives.

Inquiry-based cards like these, from the Science Museum of Minnesota, have been designed to help visitors investigate exhibits more deeply.

Mark St. John (1998)
In phrasing the inquiry enhancements, we tried to avoid questions that had specific correct answers that a visitor might know based on formal training in science. Rather, we emphasized questions that would be unfamiliar to visitors and might encourage them to conduct a genuine investigation, or that were open-ended enough to promote reflection on visitors’ own experiences.

**Inquiry and meaning**
We thought inquiries might help visitors find significance in several ways. First, we expected the inquiry enhancements to slow visitors down and engage them in considering the exhibits more carefully, giving them more opportunities to find something personally meaningful in the phenomena. Second, the inquiries invited visitors to give their own interpretations of what they were experiencing. In other words, we tried to avoid giving definitive answers or explanations that might reduce visitors’ depth of engagement and reflection on their own experiences (Gutwill, 2002). Third, the inquiries modeled the process of asking questions, which might encourage visitors to ask questions of their own and thus move repeatedly around the learning cycle.

**An evolving research plan**
Our original plan was to study five exhibits and, for each exhibit, to compare the effects of a Baseline version (the basic exhibit), a Narrative version (the exhibit with narrative enhancement), and an Inquiry version (the exhibit with inquiry enhancement).

However, as we describe more fully later, we allowed our study design to evolve over the four years of the project to take into account the findings from the individual studies as they were analyzed. In this sense, the Finding Significance project was not a single set of controlled studies, but included aspects of design-based research that evolves over time. One of the strongest forces affecting our decisions was the repeated finding that our narratives were relatively unsuccessful in enhancing visitor meaning-making, learning, or even engagement with the exhibits. Rather than persevere in proving the ineffectiveness of our narratives across multiple exhibits, we adjusted our design to explore different varieties of narratives that might be more successful. Variations that proved unsuccessful in helping visitors make deeper connections with exhibits were dropped and replaced with new versions. However, to keep some degree of continuity across all exhibits, we created and tested a “Standard Narrative” (N) and a “Standard Inquiry” (I) for each exhibit. The next two chapters describe in detail our process for creating and testing the Narrative- and Inquiry-based enhancements.

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**Scientific inquiry has its roots in the inherent restlessness of the human mind.**

*Peter Dow (1998)*
Chapter Two: Setting the Stage
The team chose video for both the narrative and the inquiry elements, assuming it would be easier for visitors to watch than to read. I was never completely happy with this decision, because I thought well-designed graphic panels might offer visitors a refreshing change from our highly technological environment. I wish we’d tested a two-dimensional print version.

Kathleen McLean, Exploratorium

The *Finding Significance* project was an extensive, iterative process that moved through a number of phases over the course of several years. In this chapter, we describe the framework for some of the key decisions that shaped the project, as well as the creation of the supporting materials and equipment. The various versions of the exhibit enhancements we describe in this chapter are presented in full on the CD-ROM provided inside the back cover of this publication.

**Constraints on the Research**

Although we had to work within numerous constraints when creating the enhancements for our exhibits, we wanted to stay as true as possible to the theoretical goals of the narrative and inquiry conditions. Some of these were related to the museum environment and audience, and some arose because we were conducting a controlled research study.

Like many science centers, the Exploratorium is a crowded, high-energy public space.

**Constraints based on environment and audience**

Because the Exploratorium is chaotic and noisy, with typical holding times of only one minute per exhibit, we searched for ways to make the exhibit enhancements as engaging and compelling as possible. For example, we chose a video format for both the narrative and inquiry enhancements rather than audio or text. We thought that this format would be the most likely to attract and sustain visitors, particularly in the case of personal storytelling. Similarly, we tried to keep the enhancements short in order to sustain visitors’ attention. (Each exhibit enhancement was comprised of four separate video clips; their total duration averaged 181 seconds for the Standard Narrative enhancements and 58 seconds for the Standard Inquiry enhancements.)
Our target audience for this research project was museum visitors, including both adults and children, and the unit of analysis was the family or other visiting group. However, we aimed both the narratives and inquiries towards adult visitors because they tend to be the label-readers and interpreters, whereas children are often likely to be the ones who initiate physical interaction with an exhibit (Borun & Miller, 1980; McManus, 1987; Serrell, 1996).

Because we were interested in understanding the effects of these enhancements on diverse audiences, we used a variety of narrators, stories, and ideas. For each narrative or inquiry enhancement developed for each exhibit, we created four separate video clips, each with a different narrator and approach, to try to increase the possibility that visitors would find something of personal relevance. Visitors who were asked to use the enhanced exhibits and then interviewed (“cued” visitors) saw the clips in predetermined sequences. “Uncued” visitors were observed (but not interviewed) as they used the exhibits and could cycle through the clips at will, using a button on the video kiosk touchscreen.

For maximum accessibility, we avoided scientific or museum jargon and tried to pitch our level of concepts and language to teenagers and adults with interest in the ideas behind the exhibits, but no specific scientific training.

Constraints based on the nature of the research
In our study, one of the ways we reduced the number of “nuisance variables” (uncontrolled factors that might affect the results) was by standardizing some aspects of the videos themselves. For example, we avoided using music, exciting or colorful backgrounds, or unrelated genres of video such as “B-roll footage” of related phenomena in the outside world—all things that might heighten visitors’ engagement but were not integral to the concepts being tested and were difficult to standardize across different versions. This is why our videos have a somewhat “clinical” look that might not be necessary outside the context of a controlled study.

We wanted to study the effects of each of the different versions on a representative sample of all Exploratorium visitors, so visitors were not given the choice of whether to view the Baseline, Narrative, or Inquiry version of an exhibit. Every visiting group saw only one (effectively random) version of the exhibit enhancements. This allowed us to avoid “selection effects,” in which different kinds of people might choose different kinds of enhancements and, thereby,
Setting the Stage

reduce our ability to understand the effects of the enhancements themselves. Similarly, we asked visitors to watch the entire video (in most cases, four clips of the same genre) at some point in their use of the exhibit, so that we wouldn’t introduce another nuisance variable by varying the degree to which they experienced the enhancements. Because of this, our interview data represent a “best-case” scenario, and we relied on our observations of uncued visitors to provide a more realistic picture of visitors’ spontaneous behaviors with the enhancements.

Choosing Exhibits for the Study

Rather than creating new exhibits from scratch, we chose to take existing exhibits and study the effects of the enhancements as “add-ons.” This allowed us to allocate most of our resources to research rather than to new exhibit development, and had the further advantage that, if the exhibit additions were successful in promoting meaning-making, we could share them with other museums who have similar versions or copies of Exploratorium exhibits. But most importantly, using pre-existing exhibits meant that we could use the original versions as a form of baseline (or control) condition to compare with the enhanced versions. In other words, we could see whether adding a narrative

It really concerns me that you controlled so many aspects of the visitor experience in the cued interviews: which videos the visitors saw, in what order, and even insisting that they had to watch all of them. Doesn’t that undermine the heart of a free-choice experience?

Chris Parsons, Word Craft, in conversation

The only difference between Baseline (left) and Enhanced (right) versions of the Aeolian Landscape exhibit was the inclusion of the video kiosk in the Enhanced label. This strengthened the comparison between the versions and allowed us to determine whether the videos really enhanced the visitor experience.
or inquiry component actually increased visitors’ meaning-making (or, conceivably, decreased it).

The disadvantage of this choice was that we were studying exhibits that were not specifically designed to support the enhancements created for them. Given the Exploratorium’s history as an inquiry-based institution, this was probably less of a problem with the Inquiry enhancements, because in that case we were adding something relatively congruent with an exhibit’s original design philosophy. Adding Narrative enhancements, on the other hand, was adding something to the exhibit that was outside the original exhibit concept—not an ideal situation from a design perspective. However, we were optimistic that compelling narratives would reveal a characteristic pattern of effects on visitors’ meaning-making, even when added on rather than integrated from scratch. Also, we believed our research would be especially relevant to other museums interested in ways to enhance their existing exhibit collections.

During the course of the project, we studied visitors’ reactions to four exhibits:

- **Light Island** (pilot study), a table-top exhibit with a central light source of white light and many devices for altering the light, including filters, lenses, and mirrors;
- **Aeolian Landscape**, a contemplative exhibit involving sand that swirls around in a cylindrical chamber, in which visitors can watch sand dunes form and dissolve, see mini-avalanches occur, and change the direction of a fan that blows across the landscape;
- **Touch the Spring**, at which visitors reach out to grasp a realistic-looking spring, only to discover that it has no substance—the spring they see is only an image produced by a parabolic mirror; and
- **Mutant Fruit Flies**, which displays living fruit flies that have various genetic mutations, resulting in features like eyes with unusual colors or the absence of wings.

Overall, we chose exhibits that displayed a variety of engaging phenomena, incorporated substantial intellectual content, and represented a common presence in science museums. Also, because they required only moderate levels of physical interactivity, these exhibits seemed to have a greater potential for eliciting personal reflection than exhibits that kept visitors highly physically active. Lastly, these were exhibits that we believed had good stories associated with them—we avoided exhibits with unknown histories or nobody on staff who felt passionately about them.

**Sources for the Narrative enhancements**
The stories we used came from our collaborators on the project, including scientists, artists, professional storytellers, filmmakers, and actors, as well as Exploratorium staff. We were disappointed that we were unable to include stories from visitors in the research, but we found that visitors were often shy and unfamiliar with the exhibits, gave appreciative comments rather than stories, or simply restated what was already contained in the exhibit label. The few visitor stories that did emerge as candidates were not seen as particularly compelling and did not make it through the formative evaluation phase (conducted with other visitors) and were therefore excluded from the final study.

From a design perspective, I found the idea of the video kiosk sitting next to the exhibit a bit curious. If you’d started from scratch you could have used the graphics, look and feel, and electronic media to reinforce the narrative approach.

*John Chiodo,*
*Academy Studios,*
in conversation
Setting the Stage

Although the paucity of compelling visitor stories was not the main focus of our project and not rigorously studied, we consider it to be an important anecdotal finding. It seemed that our definition of narrative, broad though it was, was still too constraining for visitors, and was a stretch even for most staff. We struggled to find narratives that were authentic rather than contrived, directly relevant to the exhibits rather than peripheral to them, and story-like, with a sequence of events told in the first person. Visitors may have lacked the familiarity with the exhibits to think of them as old friends, or perhaps storytelling is not the most natural mode of thinking and communicating for visitors in the context of interactive science exhibits. We discuss these ideas further in Chapter Five.

Why we used actors
During the pilot phase of the project, we tried to videotape the person who was the actual source of the exhibit narrative. However, this proved much more difficult than we had anticipated. A typical problem was that we would learn about someone connected with the exhibit who had a story to tell, but by the time they had told it once to our team scout and once more on camera, their story would start to lose its spontaneous and lively quality and would sound stale or would wander off in new and less relevant directions. By contrast, the first take was usually relevant but often suffered from technical imperfections or a nervous speaker, and was rarely usable. We realized that staff members, scientists, and artists are not trained to tell a story over and over as if for the first time.

For this reason, we turned to actors to deliver our stories in the form of scripts, with some allowance for improvisation on their part. Writing scripts gave us time to construct “ideal” stories, highlight key elements, and phrase them succinctly and without jargon, while keeping the content true to what the original speaker had told us. However, one disadvantage to scripting the narratives was a certain contrived sound that the stories acquired as we refined them over and over as a team.

Using actors also made it easy for us to have the same four people perform both the stories and the inquiries for each exhibit. This was important from an experimental design standpoint: By using the same people to deliver the narratives and inquiries, we could control the potential effects of the speakers’ personal characteristics, ensuring that neither version had any advantage over the other by virtue of the speaker’s age, race, gender, or personality. This choice thus generated a much stronger test of the exhibit enhancements. In addition, the use of actors allowed us to ensure that our group of storytellers was diverse, potentially increasing the chances that visitors would find at least one person in the videos to relate to.

Auditioning the actors
The decision to work with actors necessitated that we find appropriate acting professionals—not a common feature of museum research. Because union actors were beyond the budget of our project, we posted audition advertisements on local casting Web sites and requested assistance from a well-known acting school in San Francisco, which put us...
Setting the Stage

We decided to use actors in the videos so that comparisons between Narratives and Inquiries would not be affected by characteristics of the narrators. Actors could also tell stories in multiple takes without losing enthusiasm. (See the CD-ROM in the pocket at the back of this publication for all versions of the exhibit enhancements.)

in touch with drama students. Respondents were sent the narrative and inquiry scripts and asked to be ready to perform them for the audition. About twenty people auditioned for the four available roles. Most actors performed the monologues and were then given encouraging feedback and direction by the producer/director, so that several takes could be videotaped within about fifteen minutes. The project team then selected the final four actors based on their diversity as a group and on their ability to sound authentic in their individual performances. They were allocated to specific Narratives, once again according to the degree of fit between the actor’s personality or delivery and the script of the story. The Inquiries, being much less personal in nature, were arbitrarily assigned. Because the project spanned several years, we held two auditions; two of the original actors contributed to all phases of the project, and two new actors were recruited. (From the research perspective, this diminished our ability to make strict comparisons among the different exhibits, but it retained our ability to compare narratives and inquiries within a single exhibit because the same actors performed both.)

The final video shoots

We produced the final versions of the exhibit enhancements in the Exploratorium’s theater. The selected actors performed the exhibit scripts on a simple set with basic, non-dramatic lighting. Once several acceptable takes were recorded, we asked each actor to perform some additional “improvisational” takes where he or she stayed true to the spirit of the monologue but was free to be somewhat flexible with the wording. Some of the actors, in fact, performed their best takes in this improvisational style. The final clips used in the study were chosen by the video editor, the project director, and members of the project team based on a combination of criteria that included verbal clarity, eye contact, emotional connection with the viewer, coherence of the story (whether tightly scripted or partially improvised), and overall authenticity.

Post-production

Each video clip was digitized and captioned so that it could be understood by visitors with impaired hearing as well as non-impaired visitors who might lose some of the words in the noisy chaos of the museum. After some discussion, we decided not to include identifying information such as the
Setting the Stage

name or job title of the story’s originator, because our use of actors meant that such labels would be pointedly false, and might confuse or upset people who actually knew the exhibit developer personally.

Presenting the Videos to Visitors: The Research Kiosk

We wanted visitors to experience our enhancements as part of the exhibit, rather than as a separate element. For this reason, we developed a specialized video kiosk that could be rolled up next to an exhibit or embedded within the accompanying label. More than simply presenting the videos to visitors, the kiosk served as an intelligent research assistant, automating several key experimental functions.

The kiosk consisted of a portable cabinet holding an Apple Macintosh G4 computer, audio hardware, and a Zip drive, on top of which was mounted a touchscreen. Videos were converted to Quicktime video clips, and the software that controlled the structure of the video presentation was developed in-house using Macromedia Director, a multimedia production application with a powerful scripting language. This software created a pseudo-random set of playlists, played the video clips according to these lists, and tracked visitor and researcher actions in a text file.

The kiosk had several important features:

- **Intuitive interface**—The touchscreen had a single large “play” icon that visitors pressed to play the video clips, one at a time, whenever they were ready to begin. The great majority of visitors quickly understood how to use it.
- **Flexibility**—The kiosk’s screen could be adjusted for exhibits of different heights, and had velcro attachments for easy addition or removal of written exhibit labels as needed.
- **Simple operation**—A single keyboard command determined which set of clips was to be played, so that researchers could easily cycle among the various types of video enhancement without having to exit the program or reload a new set of files. Using the keyboard, we could play, pause, skip ahead, or replay any clip.
- **Portability**—The kiosk was on wheels and had a convenient handle. This feature allowed for easy implementation of the study’s Baseline (or control) version by quickly moving the entire unit out of the way so that the exhibit could be used in its original state.
Programmable research features—The kiosk’s software counterbalanced the order in which the video clips were played, recorded how many narratives and inquiries had been played, and tracked sample sizes, date and time, sample information, and clip sequences. These features made the kiosk much more than a video player—it was a powerful research tool. In particular, the fact that it could play any of the video enhancements at the touch of a button (or be quickly rolled out of the way) meant that we could cycle repeatedly through all the different versions of the exhibit in a single day. This “block design” technique had the enormous advantage of neutralizing the possible effects of nuisance variables such as time of day, crowdedness of the museum, or the sudden arrival of a busload of science teachers. For example, if crowding on a busy day tended to make visitors more distracted and less engaged with the exhibit being studied, we might reasonably have worried that this would affect our assessments of learning. However, because we could switch easily between different versions of the exhibit (e.g., one family used the exhibit in Baseline mode; the next family saw the Narrative enhancement videos; the next family saw the Inquiries), the effects of museum crowdedness would be spread across the different conditions of the study, and we should still be able to make rigorous comparisons among the different versions.
The biggest challenge in creating the kiosk was scripting the application to dynamically create pseudo-random playlists. The program used a complicated logic structure to ensure that the order in which clips played did not bias the research. I’m sure there are more optimal algorithms than the one I used—but it works!

*Theodore Koterwas*
Chapter Three: The Research Process
The Research Process

In this chapter, we describe the actual video enhancements that we created and studied and the process through which they evolved over a period of several years as we responded to the interim research findings for each phase of the project.

We constructed a Standard Narrative enhancement (consisting of four short video clips) and a Standard Inquiry enhancement (also four video clips) for each of three different exhibits. These video clips consisted of actors telling stories or asking questions about the phenomena associated with the exhibit. However, we also used some of our resources to explore variations of these standard enhancements. Here, we describe the various phases of the project as they proceeded, including the decision-making processes that led to the experimental variations we used. Results of the research are only outlined here and are presented in greater detail in the next chapter.

Pilot Study: Light Island

At the beginning of the project, we chose to study Light Island, a tabletop exhibit with many light-altering devices such as filters and lenses. As the research progressed, however, we gradually realized that the exhibit currently suffered from several technical and conceptual problems that were not easy to solve without a rebuild. As a result, we never completed the design of Narrative and Inquiry enhancements for this exhibit, but we came to the important realization that, to answer the project’s research questions, we would need to choose exhibits that were functionally effective for visitors and not confusing or difficult to use.

Light Island also served as an important pilot for exploring ways and places to videotape staff and visitors sharing potential narratives or inquiries. For example, our experience with this exhibit revealed that it would be virtually impossible to achieve high-quality sound and lighting on the museum floor, which led to our later enhancements being recorded in a quiet “blue room.” We also caught our first glimpse of the challenges of collecting powerful narratives.

Deborah Perry (2002)
The Research Process

Phase 1: Aeolian Landscape
During the first “official” phase of the project, we wanted to start with our best-case exhibit for creating a Narrative enhancement. We chose Aeolian Landscape, a constantly-changing miniature landscape of windblown sand driven by a fan within a circular chamber. We knew it was attractive to visitors and functionally easy to use, but our anecdotal observations suggested that it rarely moved visitors or engaged them deeply. (A typical response to this exhibit was something like “Cool. Okay, move the fan; oh, cool,” with perhaps an association made to a desert or beach scene.)

We thought that the significance visitors found in this exhibit might be greatly enhanced if we could share some of the engaging stories told about it by the exhibit developer and other staff members. In addition, we thought it had high potential for supporting contemplation or reflection because of the continually changing state of the sand in the chamber, its aesthetic appeal, and the fact that a family or group could sit around it almost like a coffee or dinner table.

While developing enhancements for Aeolian Landscape, we debated whether the most effective Inquiry enhancement would consist of four separate suggestions for exploration, or a sequence of four suggestions that built upon each other. We decided to create and test both of these variations, a Single-step (SS) Inquiry and a Multi-step (MS) Inquiry.

The SS Inquiries asked visitors to consider four independent questions, such as where they would build a shelter in the exhibit’s turbulent environment, what kinds of features in the exhibit reminded them of a sandstorm or a snowstorm, and whether the avalanches in the exhibit seemed to move upwards or downwards. Because the four SS Inquiry clips did not build on each other, they could be viewed in any order.

By contrast, the MS Inquiry enhancement used a series of questions to lead visitors around an entire learning cycle. Visitors were asked to try to find and observe the phenomenon of an avalanche, to make a prediction about how avalanches begin, to consider an explanation of how they might work, and, finally, to apply the same idea to situations beyond the exhibit. Because it was based on a sequential set of four clips, the MS Inquiry had the advantage that visitors could build on their explorations, but the disadvantage was that the sequence worked optimally only when visitors saw all the clips in order.
Results from the first phase of research showed that the MS Inquiry was no more effective than the SS Inquiry, so we chose to use the SS version as the standard for the rest of the project on the grounds that its arbitrary ordering of the video clips made it more flexible for use on the chaotic and fast-moving museum floor.

**Phase 2: Touch the Spring**
By the second phase of the project, we realized that our Narrative enhancements for *Aeolian Landscape* were not having a large impact on visitors’ meaning-making or engagement. We therefore chose an exhibit that we thought might be optimal for narrative development in a different way: *Touch the Spring* is an exhibit that is very popular with both staff and visitors and very easy to use, but it tends to engage visitors for short periods of time and offers few interactive options. The exhibit features a large spring that visitors are invited to touch, but the spring they see is actually an image created by a concave mirror, so visitors’ hands pass right through it. We thought that this might be a strong candidate for enhancement through narrative because visitors were clearly excited by the phenomenon but not sustained by it. Perhaps, we thought, narrative could extend visitors’ engagement and complement the exhibit’s hands-on aspect with a more reflective component.

While developing enhancements for *Touch the Spring*, we became concerned that the lackluster results we obtained with earlier Narrative enhancements might be occurring because we were using actors to tell stories, rather than the actual originators of the stories. In order to address this concern, we decided to try an experimental form of narrative in which each speaker told his or her own authentic story. Because these interviews tended to produce personal reactions to the exhibit rather than true stories, we also relaxed our requirement that narrative involve characters in an unfolding sequence of events. Instead of asking for stories, we invited people to comment on what they found personally meaningful or significant about the exhibit. This turned out to be an easier assignment, and we were able to obtain Commentaries of sufficiently high quality on the first take for us to use with visitors. Unfortunately, interim results from Phase 2 showed that these variations were no better than Baseline at facilitating visitors’ meaning-making, so we did not create additional Commentaries for the later phases of the project.

**Phase 3: Aeolian Landscape (revisited)**
Up to this point, the data were suggesting that our Narrative enhancements had been largely ineffective, so we paused the entire project to consider whether this really meant...
that narratives do not help visitors find meaning in science center exhibits, or whether we had simply created poor-quality examples of narrative.

The multimedia developer on our team suggested that our Narratives suffered from two main problems, both of which probably undermined the Narratives more than the Inquiries. Firstly, they seemed sterile, lacking dynamic and spectacular footage (“all tell and no show”); this was particularly problematic for the Narratives because they were closer in content to what visitors would typically see on TV and in films. Secondly, the Narratives felt contrived in terms of both the actors and the scripts. The actors were cast in the role of someone not playing a role, a situation made even more difficult by the total lack of supportive dramatic context or established formula (such as a newscast or testimonial commercial) which would help viewers to know how and when to suspend their disbelief. Similarly, the scripts had been initially intended to sound like documentaries, but when we edited them to fit into a one-minute timeframe we ended up removing most of “redundant” pauses, digressions, and repetitions that characterize authentic speech.

We consulted our advisors, who echoed our concerns that perhaps in “flattening out” the variables, we had “flattened out” the Narrative enhancements themselves. We then sought the advice and assistance of a gifted group of experts in the art of narrative, including professional storytellers, film-makers, television and radio producers, dramatists, writers, and National Park Service interpretation staff. They raised some fundamental issues, including:

- **The importance of emotional power**—Many of the people we spoke to stressed the importance of emotional and personal dimensions to a compelling narrative. A dramatist described how she used humor and controversy to bring a human dimension to dry material, while a storyteller emphasized the need for sensory detail. Several suggested tapping into “universal themes” in order to establish a quick rapport with visitors. And one person asked “You’re interested in seeing whether they make a connection to the content, but do you have any goals about them having made a connection to the spirit?”

- **The role of story structure**—Several experts from different fields talked about the power of classical story structure (conflict and resolution, discovery and denouement) in getting audiences involved, both because of the innate strengths of this structure and because of its familiarity.

**Theo Koterwas**

To me, the key difference between the Narrative and Inquiry clips in terms of authentic “feel” is the use of the first-person perspective. As soon as the actor says the word “I,” credibility becomes an issue, especially in an environment like ours in which we challenge visitors to think critically.
The Research Process

Others cautioned, however, that the particular powers of narrative might not be suited to our aim of getting visitors to make connections between the exhibits and their own lives.

- Getting visitors to engage—Given the Exploratorium’s intense focus on interaction rather than passive observation, many of the people we spoke with focused on finding ways to engage visitors actively in the video narratives. While some felt that identifying with the characters in a story was sufficient, others suggested integrating activities with the story—perhaps using riddles or puzzles that could be solved by interacting with the exhibit. Many of our advisors talked about finding ways to make a story surprising. Several others suggested ways to encourage visitors to make their own interpretations more explicitly, and one recommended providing visitors with a choice about what they wanted to hear.

- Competing with the museum environment—Several experts mentioned that the Exploratorium’s floor, with its wide array of available diversions and sensory stimuli, does not provide an ideal environment for listening and reflection. They described a psychological as well as a physical component to the environment that might encourage visitors to focus on physical interactivity and to move between exhibits without lingering. As one advisor said, “When people come to a science center, they don’t expect to have their emotions and experiences tapped...You have to let them know that it’s okay to be quiet and think.” Some experts suggested that creating “story spaces” or “areas of silence” might increase the effectiveness of narrative.

- Visitor expectations—Many experts noted that children and adults today are visually sophisticated and have very high expectations for anything they see on a screen. By presenting visitors with narratives in this format, they suggested, we were inherently competing with what they saw on television, in movies, and on computers, and we had to produce something that was up to those standards of quality. Ira Glass, creator of the radio series This American Life, also noted the importance of a convincing tone: “Stories go into our hearts more easily when they’re spoken in a normal tone of voice, by someone who sounds like a normal person. Finding a performer to do this can be hard—performers tend to perform things too big; they sell the words too hard.”

After considering all this advice, we decided to revisit Aeolian Landscape, but with a large-scale relaxation of our previously tight research constraints. We would put all of our efforts into creating dynamic Narrative enhancements; if we succeeded, we could then resume more rigorous control of variables to determine what had accounted for our success.

We contracted with three professional creators of narrative—two filmmakers and a professional storyteller—to generate their own video narratives based on our theoretical definition and relevant to the exhibit, but creative and compelling at the same time. They could use every device we had previously eliminated for reasons of experimental control, including music, special effects, intercut footage, exciting backgrounds, and new actors. We even removed the constraint of having four different short clips, so that these artists could create a single, longer Narrative enhancement if they wished. We did ask them to limit their total video enhancement to about three minutes in duration (to be comparable with the four clips in the standard Narrative
enhancement), although even this constraint was relaxed somewhat in favor of giving the artists creative freedom. The artists created the following experimental versions of Narratives:

- **Unfolding Drama**—For this version, filmmaker Jona Frank created a four-part serial drama called the X–12 Rocket Ship series, with children playing all the acting roles. This drama was the closest to a classic story, with characters facing a crisis that is eventually resolved, and was intentionally reminiscent of a 1950s television space-adventure series (such as Flash Gordon). The X–12 story had many additional variables that might have affected its impact to an unknown degree, such as evocative music, cliffhanger endings to each segment, a cast of young children, a particular style of humor, and various special effects.

- **Extended Story**—For this variation, professional storyteller Diane Ferlatte created a single extended story which she performed to a drum accompaniment. Diane had great personal energy and charisma and created an evocative story that had time to develop a plot—but again, this variation used techniques such as music and exhibit footage that may or may not have contributed to its effects on visitors.

- **Art Video**—Exploratorium filmmaker Elisabeth Spencer created a lively four-minute video entitled Hair Piece that combined still and video photography of people with wind-blown hair, edited to the Bo Diddley tune Mumblin’ Guitar. The video contained no speech and no sequential narrative but used occasional title cards, such as “God of Wind,” to refer to the exhibit’s name, Aeolian Landscape.

Two of the experimental Narratives: In the Unfolding Drama (left), children face avalanche danger when they land on a planet with spherical sand grains, a reference to avalanche behavior in Aeolian Landscape. In the Extended Story (right), a professional storyteller performs a personal narrative that highlights the role of wind as an agent of change.
The Research Process

This video featured a cast of many diverse individuals and had a whimsical, even humorous quality.

Unfortunately, once again, these Narrative variations were disappointing in their effects on visitors. Our interim results showed only a few improvements of any variation over the Baseline version of the exhibit.

Phase 4: Mutant Fruit Flies

For our last exhibit, we decided that compelling and inspirational narratives might simply be too difficult to create for exhibits that were, at their core, phenomenological. Perhaps, we reasoned, the exhibit most likely to benefit from Narrative enhancement would be one that was already quite close to human concerns in terms of its content. We therefore decided to study an exhibit from the Life Sciences area—one that highlighted the behaviors and needs of living organisms. We chose Mutant Fruit Flies, a display of different live fruit flies showing the effects of various mutations. We selected this exhibit because it displayed organisms with which visitors might already be somewhat familiar, it was easy for visitors to use, it was reliable and simple to maintain, and its background provided a diverse array of stories about the history of genetics, the quirkiness of fruit fly mutations, and the nature of working in a biological laboratory.

At this point in the project, we only had resources to conduct the Baseline, Standard Narrative, and Standard Inquiry versions of the exhibit, so no further experimental variations could be explored. But within the Standard Narrative, we did try to bring more universal human concerns to the videos, raising issues such as eating, mating, and death. As our team writer put it, “Maybe you want less PBS and

The Art Video was an experimental Narrative that showed the effects of wind in people’s hair, drawing a parallel with wind’s effects on a sandy landscape.

Mutant Fruit Flies
more Fox.” The final results of this phase of testing, together with the full results from all previous phases, are presented in Chapter Four.

A note on standardization and control
Every exhibit enhancement we created was actually a compromise between theoretical and pragmatic constraints. For each variable we considered, we had to make a difficult decision about whether to control for that variable (i.e., make it the same across all versions of an exhibit) or allow it to vary between versions, thereby losing our ability to conduct strict comparisons between them. For example, we decided to standardize the blue background of all the videos, but we allowed the Narratives to be substantially longer than the Inquiries, on the grounds that their different durations were an intrinsic part of the difference between a story and a question.

### Summary of Experimental Variations
This table summarizes the different additions to each exhibit that we created and studied in detail:

<table>
<thead>
<tr>
<th>Standard Versions of Exhibit</th>
<th>Phase 1: Aeolian Landscape</th>
<th>Phase 2: Touch the Spring</th>
<th>Phase 3: Aeolian Landscape (revisited)</th>
<th>Phase 4: Mutant Fruit Flies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (no addition at all)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Standard Narrative (personal stories spoken by actors)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Standard Inquiry (invitations to think /explore spoken by actors)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Experimental Variations of Inquiry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-Step Inquiry (invitations that build on each other; spoken by actors)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental Variations of Narrative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commentary (spontaneous perspectives, no actors)</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unfolding Drama (created by filmmaker)</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Extended Story (created &amp; spoken by professional storyteller)</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Art Video (created by filmmaker)</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
</tbody>
</table>

For each version of each exhibit (indicated by ●), we gathered the following data:

a) Cued interviews from approximately 60 visiting groups

b) Follow-up interviews with approximately 20 of the people originally interviewed

c) Uncued (discreet) observations of 150–250 visitors using the exhibit spontaneously
The Research Process

Final process for creating Standard Narratives
By the end of the project, we had reached a stable process for creating exhibit Narratives. (See the chart at right.)

Final process for creating Standard Inquiries
Although one might expect the production process for creating Inquiry enhancements to be similar to that for creating Narratives, it was actually much easier to generate compelling short questions about an exhibit. We found visitors to be a useful source of Inquiry questions, and several of our questions were gleaned simply by eavesdropping on families at the exhibits. In addition, the Inquiries did not require any of the interviewing, transcription, or editing of the Narratives. Thus, the first thirteen weeks of the Narrative enhancement production process (up to the formative testing) were reduced to perhaps one week in the case of Inquiries.

Our Process for Creating Standard Narratives

<table>
<thead>
<tr>
<th>Task</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify diverse potential storytellers</td>
<td>3 weeks</td>
</tr>
<tr>
<td>Interview all storytellers</td>
<td>3 weeks</td>
</tr>
<tr>
<td>Transcribe interviews</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Identify compelling stories</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Edit stories with writer</td>
<td>3 weeks</td>
</tr>
<tr>
<td>Test edited versions with visitors</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Actors work with scripts</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Film actors</td>
<td>1 week</td>
</tr>
<tr>
<td>Post-production film editing</td>
<td>4 weeks</td>
</tr>
</tbody>
</table>

Total: approximately 22 weeks
This chapter describes the data we collected from visitors, the statistical procedures we used to analyze these data, and the results that emerged. The implications of these results are discussed more fully in Chapter Five.

**Coding the Interviews for Analysis**

As in most social science research, the first step was to transform visitors’ answers to our questions into data that we could analyze statistically. Some of visitors’ responses were already in numerical form, such as their ratings on scales from 1 to 5 of various aspects of their exhibit interaction. For the rest, we created categories and coded visitors’ answers accordingly, sometimes coding the answer to a single question in multiple ways to capture different aspects of a visitor’s experience. (See page 57 for the questions asked of cued visitors in the initial and follow-up interviews, and for the ways in which the questions were coded.)

Because this kind of coding of responses is inherently subjective, we refined the coding scheme until two different coders scoring the same responses assigned the same scores at least 90% of the time. With this level of inter-coder agreement, we could assume that anyone using our coding scheme could reproduce similar results to those we present here. We reduced possible experimenter bias by hiding from coders which version of the exhibit each visitor had seen.

**Analyzing the Data**

We conducted two types of analyses on cued visitors’ responses to their initial and follow-up interviews. First, we conducted a “univariate analysis” by comparing the answers of the Baseline group to those of people in the Inquiry or Narrative groups, question by question, to see whether there were any differences. This procedure would tell us whether visitors’ responses to each of the questions we asked were significantly different depending upon which exhibit enhancement group they were in—and, therefore, whether the nature of the enhancements made a difference in how visitors responded to the exhibits.

Second, where sample sizes warranted it, we conducted a “multivariate analysis” (specifically, a stepwise logistic regression) in which we looked at responses to all the questions at once, and identified a set of key questions that best distinguished among the responses of different groups of visitors. The multivariate analysis served two purposes: (1) it showed us which questions best revealed differences among the different versions of the exhibits; and (2) it allowed us to control for the possible effects of visitor demographic variables, such as age or gender, that might have affected visitor responses but were not the focus of our research. In this report, we focus particular attention on results that showed up in both univariate and multivariate analyses.
Following conventions of social science research, we report
only findings that had a probability of less than 5% of occur-
ing by chance. In keeping with the tone of this document
for a general museum audience, we have omitted the details
of the statistical calculations and their precise results.

Effects of the Standard Narrative Enhancements

Summary—Table 1 shows that Narratives got people thinking,
engaged their background interests or pleasures (especially
in science), and were memorable. However, they did not
affect the number or nature of connections visitors made
to their own lives, and they reduced experimentation and
discovery at the exhibit.

• Got visitors thinking—Visitors who watched the Narratives
were more likely than Baseline visitors to say the exhibit
got them thinking (Q9). This difference appeared in both
univariate and multivariate results (after controlling for
demographic differences), and was most evident in the
case of Touch the Spring. The following are examples of
Narrative visitors explaining how that exhibit (including
video enhancement) got them thinking:

It makes you realize that mirrors are just not something
that you comb your hair and you look—there are actually
other purposes for them. Like the video, when it said that
Lockheed uses them, it made you think about how they
use them, how they project pictures back to the earth.

The clarity of the mirror, it must be a snazzy, high quality
mirror, and the part about the image not really being on
the surface even though it looks that way.

• Engaged background pleasures—More Narrative than
Baseline visitors felt that their understanding or apprecia-
tion of the exhibit had been aided by something in their
background with an emotional quality (Q19). For example,
an “interest in the environment” or a “pleasure in camping”
helped visitors relate to the Aeolian Landscape exhibit.
However, the most common responses were about
enjoyment of science more generally, which seems harder
to attribute to the effect of the Narrative enhancement.
Perhaps visitors felt encouraged by the focus on personal
perspectives to share more of their own interests in
general, when answering this question.
• **Memorable**—Several months after their visit, almost every visitor remembered the exhibit, but Narrative visitors were more likely to remember that they had seen videos, and the specific contents of the videos, than Inquiry visitors. (Baseline visitors could not be asked this question, having seen no videos).

• **Visitors anticipated seeing things differently**—There was some evidence that more Narrative visitors anticipated that they would see things differently after their experience (Q6). This was most visible in the Mutant Fruit Flies exhibit, where visitors described both a new understanding of evolution and diversity, and a greater respect for flies. (However, follow-up interviews four months later did not suggest that Narrative visitors had actually changed their perspectives more than Baseline visitors.)

• **Engaged imagination**—There was some evidence that Narrative visitors felt the exhibit had engaged their imagination more than the Baseline visitors did (Q11). However, this effect was not strong enough to surface in analyses of individual exhibits.

• **Reduced interactions and discoveries**—Narrative visitors were less likely than Baseline visitors to report having discovered or figured out something while using the exhibit (Q7), either about the exhibit or about the larger world. They were also less likely to anticipate doing something new based on their experience (Q6), and less likely to remember the details of their physical interactions with the exhibit a few months later (F1). Similar reduced levels of exploration showed up in our observations of visitors using the exhibit spontaneously in stand-alone mode on the museum floor. Narrative visitors were less likely than Baseline visitors to use the flashlight or search for the spring in the Touch the Spring exhibit, and less likely to use multiple magnifiers to observe the flies in Mutant Fruit Flies.

• **Increased holding time for one exhibit only**—Timing studies of the spontaneous users showed that the Narrative enhancement increased the average time spent at Touch the Spring (the exhibit with the shortest Baseline holding time), but no change was observed for the other two exhibits.

• **Overall rating**—When Narrative visitors were asked whether the enhancement made the exhibit better or worse, 44% said that it made the exhibit “much better”—a positive response, but not quite as high as that for the Inquiry enhancements.

In addition to the cued interviews, we discreetly observed visitors using the exhibits spontaneously in order to get data on holding times and visitors’ physical interactions.
Examples of positive responses:

It’s good to have other people’s thoughts and opinions. When you’re thinking by yourself your own mind rarely surprises itself.

I hadn’t thought about insects dying in that confined space. It made me aware of the other things besides the visible aspects of the exhibit.

I think it adds a different dimension. Without the videos, there’s only the more scientific explanations, with the rays of light and stuff. But these relate it to other life experiences, like making the mirror more interesting in the one about the spy satellite.

They just gave you some kind of more human thought on it. Brought up topics as to why this means anything.

Examples of critical responses:

The video wasn’t a huge connection to the actual exhibit. It didn’t explain the exhibit at all.

It doesn’t add to the experience, watching other people’s reactions to it—it’s a great experience on its own—you don’t need to hear how other people felt about it.

Effects of the Standard Inquiry Enhancements

Summary—Compared to the Baseline exhibits, Standard Inquiry enhancements increased the number of connections visitors made to their own lives. The Inquiries also got visitors thinking, helped them talk with others in their group, and extended the time that visitors chose to spend at the exhibits. Inquiry visitors said they had answered the questions posed to them in the videos, but they generally did not go beyond the questions to try their own experiments.

• Evoked more connections—In a question of central importance to this project, Inquiry visitors made more connections between the exhibit and their own lives (Q5) than Baseline visitors. The number of connections was most increased in the case of Touch the Spring. Visitors’ connections revealed the diversity of their personal experiences, but they also tended to answer the questions that had been posed earlier by the Inquiries:

Oh yeah, we were all talking about that, it was the video that prompted me: When I’m driving along the road, and I see something that looks like a puddle and I get close and it isn’t a puddle. And of course holograms, but that’s more exhibits, it isn’t real life. [Also] I was wondering—it’s more a question—but I feel that way about rainbows, because they’re there and they move, and they have an illusory quality, but I have a feeling that it’s an entirely different phenomenon.

I live in Alaska, and you can dig under the snow to escape the wind. I also think of how wind affects the sea and the waves. I like to travel, so I’m kind of drifting with the sand in an abstract way. It takes me from here to the Sahara desert when I’m fascinated about where the sand is.

• Got visitors thinking—Visitors who watched the Inquiries were, like those who saw the Narratives, more likely than Baseline visitors to say the exhibit got them thinking (Q9). This difference was seen in both univariate and multivariate results, and was the most apparent in response to the Aeolian Landscape exhibit.

• Aided conversations—Visitors who saw Inquiry enhancements were more likely than Baseline or Narrative visitors to say that the videos and label(s) helped them talk with their children (or others in their group, if no children were present):

The video that said we’re all mutants was my favorite because I thought it was funny and it brought you into the exhibit. My least favorite was the names one, because these flies don’t appear to be named, so it’s not connected.

Visitor at Mutant Fruit Flies (with Standard Narrative enhancement)
### Table 1: Interview Results for the Standard Narratives (N) and Standard Inquiries (I)

<table>
<thead>
<tr>
<th>Question Number</th>
<th>What was Coded</th>
<th>Which Group Scored Significantly Higher</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Narrative versus Baseline</td>
</tr>
<tr>
<td></td>
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<td>Univariate</td>
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<td>how interesting was exhibit</td>
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<td>5</td>
<td>number of connections to own life</td>
<td></td>
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<tr>
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<td>depth of connection to own life</td>
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<tr>
<td>5</td>
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<td>6</td>
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<td>6</td>
<td>anticipate seeing things differently</td>
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<tr>
<td>6</td>
<td>anticipate doing something new</td>
<td>B</td>
</tr>
<tr>
<td>7</td>
<td>discovered about exhibit</td>
<td>B</td>
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<tr>
<td>7</td>
<td>discovered beyond exhibit</td>
<td>B</td>
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<tr>
<td>8</td>
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<td>B</td>
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<td>8</td>
<td>thought beyond exhibit</td>
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<tr>
<td>9</td>
<td>exhibit got you thinking</td>
<td>N</td>
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<td>10</td>
<td>exhibit got you feeling</td>
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<td>got you using your imagination</td>
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<td>12</td>
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<td>13</td>
<td>video made exhibit better</td>
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<tr>
<td>12.5</td>
<td>helped you talk with children</td>
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<td>19</td>
<td>professional background helped</td>
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<td>19</td>
<td>life experience helped</td>
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<tr>
<td>19</td>
<td>emotional background helped</td>
<td>N</td>
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<tr>
<td>F1</td>
<td>remembers physical interaction</td>
<td></td>
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<tr>
<td>F2</td>
<td>remembers thinking or feeling</td>
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<tr>
<td>F3</td>
<td>has made a connection to exhibit</td>
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<tr>
<td>F4</td>
<td>perspective has changed</td>
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<td>F6</td>
<td>has talked with someone</td>
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<td>F6</td>
<td>has talked about exhibit</td>
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<td>F6</td>
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<tr>
<td>F7,8</td>
<td>remembers details of video</td>
<td></td>
</tr>
</tbody>
</table>

**KEY**

N = Narrative group scored higher
I = Inquiry group scored higher
B = Baseline group scored higher
White (empty cell) = no significant difference between groups
We discussed the questions kind of thoroughly. We reached a consensus rather fast on all of them except the avalanche.

It gave you something to look for. It gave something to discuss with others. It had focused questions. If I had been by myself, with no video, I would have just looked and left.

• Increased exhibit holding time—Observations of visitors using the exhibits spontaneously showed that Inquiry enhancements increased the average holding times of all three exhibits. At Mutant Fruit Flies, the Inquiry enhancement increased holding times even more than the Narrative enhancement did, despite all its clips having shorter durations.

• More clips viewed—When the exhibit was simply put on the museum floor without an interviewer, visitors approaching the Inquiry version chose to watch almost twice as many video clips as visitors approaching the Narrative version. Of course, the Narratives were significantly longer, so perhaps a fairer comparison is to count how many visitors who had already watched all or part of one clip decided to play a second clip. This analysis showed that Inquiry visitors were more likely to play a second clip than Narrative visitors (67% versus 43%).

• No increase in experimentation—In most cases, the Inquiry visitors did not engage in more physical interactivity with the exhibit than Baseline visitors. In fact, Inquiry visitors were less likely to report trying things with the exhibit that were not already in the video or label (Q8), presumably because they did not look further than carrying out the activities suggested in the questions. (Incidentally, the apparent success of Inquiry in Qs 6 and 7, shown in Table 1, merely reflects the fact that Narratives scored even lower than Baseline in these questions. An equivalent effect is responsible for the apparent success of Narratives in Q8.)

• Overall rating—When Inquiry visitors were asked whether the video enhancement made the exhibit better or worse, 60% said that it made the exhibit “much better”—significantly more even than Narrative visitors.

Examples of positive responses:

They’re interesting and short so you don’t sit for a long time; they make you think.

It brought us into what we’re supposed to look at. It didn’t give you a conclusion but allowed you to get there on your own.

Gets you thinking—I wouldn’t have thought of the questions if I just looked at it. Immerses you in the experience. Makes you think about yourself—it was the best part.

• Critical responses—While many visitors particularly liked the open-ended, challenging nature of the Inquiry questions, a minority expressed frustration at not getting more information or explanation at the end:

I would have wanted them to be more didactic and explain more, if the questions they present are answered more fully.

It proved harder than we expected to summarize the interview data. Because we coded individual questions optimally, we had different types of variables (continuous, ordinal, and dichotomous) that didn’t combine easily. So our results, while fairly comprehensive, didn’t link back to the our original learning cycle as tightly as we would have liked.

Joshua Gutwill, Exploratorium
Results

Effects of Multi-step Inquiry Enhancement

The results for Multi-step Inquiry, which used a series of video clips to lead visitors around an entire learning cycle, were similar to those for Standard Inquiry, so we do not discuss them in detail.

Effects of the Commentary Enhancement

Commentary—the experimental narrative in which authentic speakers talked about Touch the Spring in Phase 2—drew responses from visitors that were essentially the same as those from Baseline visitors. A few exceptions follow:

• Fewer discoveries about the exhibit—Commentary visitors were less likely than Baseline visitors to report having discovered or figured out something about the exhibit (Q7). Perhaps this is because the video kiosk served as a primary interpretive guide, drawing visitors’ attention away from the label that included a diagram and explanation of how the exhibit worked.

• Less physical interactivity—Similarly, the observation study of visitors using the exhibit spontaneously showed that Commentary visitors were less likely than Baseline visitors to reach into the exhibit to find the real spring hidden inside. This probably also reflects the fact that, in the presence of the video, visitors spent less time looking at the diagram that shows the location of the real spring.

• Increased holding times—The Commentary videos did increase the exhibit’s holding time above that observed with the Baseline exhibit.

Effects of the Experimental Narrative Enhancements (Unfolding Drama, Extended Story, Art Video)

Table 2 shows that of the three experimental narratives used in Phase 3, the Extended Story (about the ever-changing nature of the wind) was the only one to show improvements over Baseline on any of our interview questions.

• Connections were more abstract or causal—Visitors who used the exhibit with the Extended Story made connections to their own lives that were more abstract or more frequently involved both causes and effects. For example, Extended Story visitors were more likely than Baseline visitors to talk about the effects of wind or other change agents in their own lives (versus object-based connections such as being reminded of the beach because there is sand there).

• Provoked thinking beyond the exhibit—Visitors who saw the Extended Story were more likely to say they had thought about something other than what was already in the labels or video. For example, visitors were provoked to think about storms they had experienced in their own lives, or about their own childhoods.

The Unfolding Drama increased the holding time of visitors over Baseline, but showed no other effects; and the Art Video showed no effects over Baseline on any of our measures.
<table>
<thead>
<tr>
<th>Question Number</th>
<th>What was Coded</th>
<th>Commentary versus Baseline</th>
<th>Unfolding Drama versus Baseline</th>
<th>Extended Story versus Baseline</th>
<th>Art Video versus Baseline</th>
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<tbody>
<tr>
<td>1</td>
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<td>F7, 8</td>
<td>remembers details of video</td>
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</table>

**KEY**
- **C** = Commentary group scored higher
- **UD** = Unfolding Drama scored higher
- **ES** = Extended Story scored higher
- **AV** = Art Video scored higher
- **B** = Baseline group scored higher
- **White** (empty cell) = no significant difference between groups

*Table 2: Interview Results for the Experimental Narratives (C, UD, ES, and AV)*
Results

Learning Styles

Early in the project, a colleague suggested that visitors’ responses to the exhibit enhancements might also depend on their learning styles. We therefore included in the interview an assessment of learning style, using the “watching versus doing” dimension of the 4MAT Learning Type Measure (About Learning, Inc., 2000). But the findings showed that learning style, as assessed by these 11 questions, did not correlate with any of the other items we assessed. In other words, visitors with different preferences for watching versus doing when they learn, nevertheless responded similarly to the various video enhancements.

Could visitors tell we were using actors instead of original storytellers?

The pie chart shows that a majority of visitors (57%) believed that all four of the Narrative speakers were authentic, even when the possibility of actors was suggested to them. Visitors’ responses to actors seemed also to depend on the quality of the actor: In a pilot study we conducted with a very experienced actor, visitors were no better than random chance at guessing which of two people was the real speaker and which the actor.

How much did speaker authenticity matter to visitors?

We asked visitors who thought that any or all of the speakers were actors (43% of visitors) whether this interfered with their ability to relate to the stories. About half said “yes” and half said “no,” also shown in the pie chart.

This pattern of roughly equal numbers of visitors expressing comfort and discomfort with actors is similar to what we found in a pilot study: In that study, visitors were asked to identify which of two speakers they thought was an actor, and to say which speaker they preferred. Of those who had a preference, 56% actually preferred the person they guessed was the actor. Those who preferred the “real person” gave a variety of reasons, including the authenticity of the speaker and related issues about the personality of such a real person (e.g., “less condescending,” “seemed like a nicer person”), as well as presentation issues (such as clarity of speech and degree of animation). Those who preferred the person they thought was an actor most often gave reasons that related to professional skill, such as “seemed more polished,” “more confident in front of a camera,” and “better at speaking.” A few even mentioned authenticity as one of the reasons they preferred the “actor;” for example, “She made it sound conversational and spontaneous, so she would be the actress.” Overall, then, it seemed that most visitors were less concerned with the actual authenticity of the storytellers, and more concerned about the clear, dynamic, compelling quality of their presentations.
If visitors were bothered by the actors, did that impact their learning in other ways?

In most of our assessments, visitors' learning and meaning-making was not affected by their responses to the actors. However, there were three exceptions:

• The 43% of visitors who thought they were watching actors also found the exhibits less interesting than visitors who thought they were watching real storytellers.

• Interestingly, visitors who thought they were watching actors tended to spend more time at the exhibit.

• The 20% of visitors who felt that they were watching actors, and that this interfered with their ability to relate to the stories, were more likely to think of something new, beyond what was presented in the label or video.

Perhaps visitors who identified the speakers as actors might be characterized as “discriminating noticers”—visitors who studied the exhibit and the videos carefully, and explored their own thoughts and responses if they found the actors annoying. However, this is only speculation; these visitors did not seem to share any distinguishing demographic features (such as a higher educational level or a particular gender).

Did visitors realize that the people telling Standard Narratives were actors?

- No, thought authentic speakers
- Yes, but no problem
- Yes, and this interfered

20%
57%
23%
Results

Visitors’ Responses to Length of Video Clips

The chart below shows visitors’ responses to a question about whether the video clips they saw were too long, too short, or about right. With the exception of the three experimental narratives (UD, ES, and AV), the vast majority of visitors rated the lengths of all the video enhancements as “about right.” This is particularly important given that the average length of the Standard Narrative enhancement was about three times that of the Standard Inquiry. It seems that visitors were comfortable adjusting to a duration that matched the genre of enhancement (at least up to the one-minute threshold per story).

What Visitors Valued in Their Favorite Clips

We learned some lessons about what visitors particularly valued in the video clips, mostly by asking them which were their favorites:

- Visitors valued Narrative clips that were relevant to the exhibit, easy to relate to, informative, and new to them; that gave an understandable explanation of what the exhibit was made of, how it was built, how it works, or of a key concept; that showed the process behind an exhibit, including its history, creator, or purpose; and that were personal, true, or funny.

<table>
<thead>
<tr>
<th>Type of Enhancement</th>
<th>Total Length of Video Clips (in seconds)</th>
<th>Visitors’ Reactions to Length of Video Clips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Inquiry (comprised of 4 clips)</td>
<td>0s: 58, 50s: 119, 100s: 180, 150s: 145, 200s: 242, 250s: 181</td>
<td>about right</td>
</tr>
<tr>
<td>Multi-step Inquiry (4 clips)</td>
<td></td>
<td>about right</td>
</tr>
<tr>
<td>Standard Narrative (4 clips)</td>
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<td>about right</td>
</tr>
<tr>
<td>Commentary (4 clips)</td>
<td></td>
<td>about right</td>
</tr>
<tr>
<td>Unfolding Drama (4 clips)</td>
<td></td>
<td>about right</td>
</tr>
<tr>
<td>Extended Story (1 clip)</td>
<td></td>
<td>about right</td>
</tr>
<tr>
<td>Art Video (1 clip)</td>
<td></td>
<td>about right</td>
</tr>
</tbody>
</table>


• Visitors valued Inquiry clips that were relevant to the exhibit, connected to the real world, new to them, challenging, hands-on, surprising, or funny; and that gave them things to look for, or got them thinking.

• Visitors valued speakers who were clear, personable, plausible, and interested.

Across all types of enhancements, many visitors expressed appreciation for the video as a presentation medium, mentioning ease of use by children, support for a range of learning modes, and relief from the burden of reading experienced elsewhere in the museum.

Highlights from the Follow-up Interviews

Aside from the differences already reported between different versions of the exhibit, the follow-up interviews showed some interesting results:

• Fully 60% of visitors had talked to someone else about their experience with that exhibit since leaving the museum, and this was independent of gender, age, educational level, formal training in science, or whether the group included children. This shows that for most people, using the exhibit was an experience worth sharing.

• Of those who did talk about the exhibit after their visit, almost half (49%) talked about the research aspect of the experience—the way they were recruited, the fact that they were interviewed for a research project, or the thank-you gift that they received. In fact, this was more common than talk about the exhibit itself (43%) or about connections beyond the exhibit to the outside world (43%). For example:

  Mostly it was not so much the content of the exhibit, it was more about the experience, the interview. I did mention the landslide sliding up, but it was basically about simply the fact that we had interacted with one of the staff people for the first time there. I come to the Exploratorium pretty often and this was the first time I encountered that. I enjoyed it a lot, and the fact that we got toys too!

• For 28% of visitors, something in their lives since their visit had reminded them of the exhibit. Most had been stimulated by experiences in nature or through informational media such as television or the Internet. Examples include:

  I watched a show on the Discovery Channel about satellites and that reminded me about the guy saying that that’s where the mirror came from, or the myth about it being from a satellite.

Visitor at Mutant Fruit Flies (with Standard Inquiry enhancement)
Results

- When asked whether their experience with the exhibit had changed the way they looked at something else in their lives, 22% of visitors said “yes.” Answers varied from the concrete to the spiritual:

  Well, it kind of changed the way I look at mirrors. I mean, a flat piece of glass or something can be curved and do amazing things.

  Yeah, a lot of things. You think your husband is doing something you think is bad but he’s actually not. Or the kids, that they’re actually doing something but they’re not. You see, human beings sometimes see things that aren’t really what it looks like. Sometimes…when you double look again, you see it the right way.

  It has changed my excitement and feeling on projects I can do at home, sort of rekindled the tinkerer within, and the artist too—my interest in doing kinetic sculpture.

  I think what I could say is that I’m more willing to look at stuff that I wouldn’t before. I’m not interested in flies, but perhaps it opened me up a bit to check out stuff that I’d usually find boring and not want to look at.

Summary

Both the Standard Narrative and Inquiry enhancements were seen by visitors as a significant improvement to the exhibit, and both improved some aspects of visitors’ engagement and learning, such as getting visitors thinking. However, Inquiry visitors scored higher than Narrative on several measures, and only the Inquiry enhancements increased the number of connections visitors made between the exhibit and their own lives—a key finding for this project. Among the experimental narratives, the Extended Story showed some success: these visitors were more likely than Baseline visitors to think about something beyond the exhibit, and their personal connections to the exhibit were more abstract in quality.
Chapter Five: Lessons Learned
Lessons Learned

In this chapter we discuss some of the key results of the research, suggest implications for the museum field, and present some broader insights we gained from the project.

Discussion of Key Results

Like many other examples of social science research, the results of our study may be viewed in various ways. Nevertheless, our project team makes the following interpretations:

1) Visitors’ ability to make connections can be enhanced. In our efforts to enhance visitors’ personal meaning-making, our most important finding was that two kinds of enhancements seemed to help visitors make connections between the exhibit and their own lives. Specifically, the Standard Inquiry enhancements increased the number of connections visitors made, and the Extended Story increased the abstract level of connections, encouraging visitors to connect to the cause-and-effect relationships embodied in the exhibits rather than their surface features.

2) Narrative and Inquiry promoted thinking, but not necessarily feeling. Although both Narrative and Inquiry enhancements seemed to get visitors to think more, neither seemed to enhance the emotional aspects of visitors’ experiences. Specifically, neither type of enhancement increased visitors’ feelings or emotions, engaged their imaginations, or evoked connections to their own lives that had a personal quality (i.e., when visitors go beyond making a generic connection and talk about something in terms of its relationship to their lives in particular: “I have Crohn’s Disease and I know a hospital in Israel is doing gene studies; a cure would be fantastic.”). This lack of affective or personal response was somewhat disappointing, given our hopes to involve visitors at an emotional level (with the Narratives in particular). Perhaps we never found the right stories to move visitors in a profound way.
Lessons Learned

3) It is extremely difficult to create compelling, relevant narratives to enhance interactive science exhibits. It may be tempting to blame our blue screens or lack of B-roll footage for constraining many of the narrative enhancements and reducing their emotional impact. But even so, it seems striking that none of our attempts—even those with music, humor, high drama, and child actors—got visitors to feel emotion or to be taken “beyond the museum” any more than the exhibits in their Baseline conditions. Despite working at the institution that had created these exhibits—an institution therefore relatively rich in potential stories about them—we struggled mightily to find brief, compelling narratives that were closely tied both to the exhibit and to visitors’ own life experiences (“something I can relate to”), and that also provided something fresh and new for them to discover. The more we embraced stories that might be riveting (such as tales of avalanche survival), the more peripheral our connections became to the immediate exhibit experience. Visitors wanted the stories they heard to be relevant to the exhibit as they experienced it—even the story about jumping down dunes in Colorado was criticized by some visitors for being irrelevant to Aeolian Landscape.

4) Visitors did not stray far from the material we provided. When we looked more closely at the places where the enhancements were more successful than exhibits in the Baseline condition, we found that most visitors stayed quite close to the material we gave them rather than using it as a model from which to explore entirely new directions. Overall, visitors embraced the fresh perspectives in the Narratives but seldom used their experience as an opportunity to think about something not already in the label or video (at least, no more than did Baseline visitors). Similarly, visitors enjoyed trying to answer the Inquiries we gave them but did not return to the exhibit with new explorations of their own. Even the connections they made to their own lives—which were greater in number than those made by Baseline visitors—mostly reflected ideas that had been suggested by the Inquiries quite directly.

For example, at Touch the Spring, Inquiry visitors made more frequent connections to their own lives, but the most common source of this increase seemed to be optical illusions, something which was explicitly suggested by one of the Inquiry clips. Similarly, at Aeolian Landscape, visitors made more connections, but the greatest source of this increase seemed to be connections involving snow and avalanches, the explicit focus of two of the Inquiry clips for that exhibit. Even the Extended Story enhancement, which increased the level of abstraction and the quality of causal reasoning of visitors’ connections to the
Lessons Learned

I see this study as supporting Bruner’s idea of two modes of thought: Maybe narrative is more appropriate in history museums where you’re elucidating the pattern of events through time, but inquiry is wonderful in science museums where you’re shedding light on how the world works. A single technique of meaning-making may not work for all disciplines.

Minda Borun, Franklin Institute, in conversation

exhibit, can actually be viewed as providing very direct support for just this type of reasoning. Specifically, many ES visitors engaged in cause-and-effect reasoning about the wind as an agent of change in their own lives. While this was a legitimate and important connection, it was suggested quite directly by the storyteller’s repeated references to the ever-changing wind and its effects on fires or weather patterns.

5) Visitors did not show much evidence of movement around the learning cycle. We were probably overly ambitious in thinking we could encourage visitors to move several times around the learning cycle by themselves. Instead, it seemed that the video was one more resource they brought to their one-time sense-making experience. When used spontaneously by visitors in stand-alone mode, the enhancements did not increase visitors’ exploratory use of the exhibit over Baseline, nor did the videos increase the time visitors spent using the exhibit while no video was playing. (In fact, this “playing-on-your-own” time often decreased compared to Baseline.) In other words, even if visitors chose to stay longer at an exhibit to watch a Standard Narrative clip, the experience did not induce them to play with the exhibit on its own, without the video, any longer than Baseline visitors.

6) Visitors did enjoy the exhibit enhancements. In spite of these limitations in some of our more ambitious measures of outcome, one clear finding was that visitors in both Standard Narrative and Inquiry groups thought the video enhancements improved the exhibits overall, and for the most part, they expressed appreciation for the way the videos offered multiple perspectives or ways to access the exhibit, without the need to read.

Implications for Museum Professionals

At the risk of oversimplifying a complex project, we present some implications of our results for museum professionals:

1) Adding Inquiries and Narratives to existing exhibits can enhance the visitor experience. In our study, visitors enjoyed having multiple perspectives or multiple access points when interacting with an exhibit, reported that the enhancements got them thinking more, and felt that the videos improved the exhibits overall. Such improvements might be even greater if the enhancements and exhibits were more fully integrated from the outset.

2) Both Inquiries and Extended Stories can help visitors make personal connections, but not radically novel ones. Inquiries can help visitors make connections between an exhibit and their own lives, while certain kinds of stories can change the quality of those connections. However, visitors’
new connections tend to be closely related to the materials presented in the enhancements, and sometimes an engaging enhancement can even limit visitors’ own explorations.

3) It may be unrealistic to think we can move visitors in powerful ways with stories about our interactive science exhibits. As museum professionals, we often hear accounts of personal narratives bringing a topic to life or moving visitors deeply, but these are often related to historical events and life-or-death human struggles, or even to the history of science rather than science per se. In trying to bring the power of narratives to interactive science exhibits, we need to address environmental challenges such as noise, chaos, uncomfortable seating, and a space where visitors face pressure to keep moving. We need to use storytellers who are clear, dynamic, and personable, even if they are not the originators of the stories.

At a deeper level, however, we may be facing challenges posed by the domain of science itself. To the extent that our exhibits embody universal principles rather than anecdotal events—a fundamental and cherished goal of science—it may be that the narrative form simply does not easily mesh with a depersonalized, repeatable display of natural phenomena.

4) Inquiry enhancements are much easier to create. By comparison with Narratives, compelling Inquiries are much easier to create—and, based on our findings, are met with greater visitor appreciation. The best Inquiries seem to serve as scaffolds for family conversation, focusing visitors on aspects of the exhibits they might not have noticed, by asking questions that are novel and intriguing yet answerable in multiple ways without the need for specialized science training.

One of the features that may contribute to the Inquiries’ success is their brevity. By contrast, Narratives unavoidably require a certain amount of time to unfold. Not only does this mean that Inquiry visitors can engage in “bite-sized chunks” of activity, but the inquiries seem to slip more easily into a family’s existing conversation, without the passive “performance” feel of a Narrative.

For some time, visitor researchers such as Paulette McManus (1989), Judy Rand (1990), and Beverly Serrell (1996) have been urging us to create labels with a conversational tone, and to avoid giving a museum’s official voice the persona of a dominating know-it-all. In this regard, brief, pointed questions may encourage group conversations even more than the most fascinating narratives, at least while the group is still interacting with the exhibit. (On the other hand, visitors in our study were more likely to remember the details of the Narratives over time, so perhaps such stories might have a delayed potential to provoke family conversations beyond the visit. This possibility deserves further study.)

5) Visitors’ responses to the enhancements do not systematically depend on their learning styles, at least as assessed by the “watching versus doing” dimension of the 4MAT Learning Type Measure. While we only assessed one dimension of learning style (rather than the usual two dimensions), we chose the dimension that seemed most likely to differentiate between visitors who prefer to listen to stories and those who prefer to engage actively in their own inquiry-based explorations. Our results therefore challenge the assumption that only certain kinds of visitors will be engaged by certain types of enhancements.

In the end, I believe one of the reasons we did so well with the inquiry elements was that Exploratorium staff are expert at this form of engaging with the world. We aren’t experienced in the development and fleshing out of narratives, nor are staff really comfortable placing our exhibits within such a context.

Kathleen McLean
Lessons Learned

Insights into the Research Process

A key goal of this project was to conduct rigorous educational research in a science museum, and to question some of the field’s assumptions about what makes good exhibits. Here we share some of our insights about doing this kind of research.

1) Trade-offs between realism and rigor—Throughout the project, we struggled with a deep research tension. On the one hand, we wanted our enhancements to be compelling, effective, and realistic in terms of what would work in a real museum setting. This encouraged us to create varied, creative, individually strong enhancements—but the disadvantage was that such enhancements would differ from each other and from Baseline in so many ways that, if they worked, we could never pin down the qualities that made them successful. The study would then become a comparative evaluation, revealing the differential effects of different specific enhancements but never the underlying design principles.

On the other hand, if we decided to do rigorous experiments—controlling variables so we could pin down the factors that accounted for the differences we might find—our enhancements could begin to feel standardized, constrained, and even contrived. Should we create wonderful things we didn’t understand, or contrived things we did? In the end, we used both approaches: We kept Standard Narratives and Inquiries constant across the various phases of the project, but we also created experimental versions of narrative and inquiry to explore a larger territory of possibilities. Similarly, within each phase of the study, we controlled for some variables (e.g., ensuring that visitors played all four clips in their enhancement, and not allowing visitors to choose which version they saw or the order of the clips), but we let visitors choose when they watched the clips, how much time they waited between clips, whether they attended to the clips or talked over them, and how they let the clips affect their activity, if at all. For us as researchers, the project was a constant dance of what to constrain, and what to let vary.

In this sense, our research felt a bit like catching wild animals: If you make your net too small, you risk catching nothing. But if you make it too big, you know the animals are in there somewhere but you can’t get a good look at them. Experimental design is the art of making a study broad enough to obtain results, but small enough to be able to understand them properly once you have them.

...it sometimes takes a while for the full meaning-making potential of an exhibit experience to ripen...We are so results-driven that our conventional assessments may miss some of the most interesting outcomes of our work.

*Michael Spock (1999)*
2) **Trade-offs between depth and breadth**—We also struggled with a tension between creating multiple versions of the enhancements (“Couldn’t we just try this new kind of narrative?”) and studying visitors’ responses with multiple methods to be sure we weren’t missing something (“Couldn’t we just add this assessment?”). Once again, in an effort to gain the benefits of both approaches, we tried a little of both.

For example, we used cued interviews (explicitly inviting visitors to use the exhibit and answer questions afterwards) to study visitors’ meaning-making under the best-case conditions of maximum attention. Later, we added the observational studies of uncued visitors to find out about holding times and spontaneous visitor behaviors. But we diverted our remaining resources towards trying different versions of the enhancements, and so our study lacked process data such as conversational analysis, which would have been a valuable complement to the other two methods.

3) **There are some things that you can never prove**—One of the limitations of this kind of research is that we can never prove that a type of exhibit enhancement doesn’t work in general. We can prove that a particular enhancement (such as an Unfolding Drama) didn’t work in this situation, but we are always open to the criticism that “you didn’t test the best kind of unfolding drama.” By contrast, a single example of an effective enhancement proves that it can be done.

4) **We recommend that different versions of an exhibit be easily interchangeable**—To control for the many nuisance variables in the museum setting (such as temperature, crowdedness, interviewer personality, etc.), we designed our studies so that we always rotated through all versions of the exhibit in a short time (in our case, a single interview for each version). This proved to be a simple but powerful strategy that meant that we could collect data on a variety of days without worrying about comparability. We recommend it to others designing controlled experiments on the museum floor.

5) **We are still learning how to assess meaning-making**—Our field continues to wrestle with ways to define and assess meaning-making. For example, Falk, Moussouri, and Coulson (1998) have proposed a concept-mapping strategy that assesses four dimensions of visitors’ understanding: extent, breadth, depth, and mastery. The strategy we used put a lot of emphasis on visitors’ immediate connections with events in their own lives (which we called “significance” and which we measured directly in Q5). But we also tried to assess related aspects of learning and engagement, such as time spent at the exhibit, exploratory behaviors, novel thinking, and emotional responses. This multi-faceted approach allowed us to throw a wide assessment net, which seemed appropriate at a time when the field is still hotly discussing what it means for museums to support personal meaning-making.

As someone who’s constantly trying to apply evaluation findings to design decisions, I can see the field has developed some solid principles, but any exhibit concept still has a vast multitude of possible permutations, most of which can never be individually assessed.

*John Chiodo, in conversation*
Lessons Learned

Looking Back, Looking Forward

While we are proud of this work, in every research project there are decisions the team would make differently if they were starting over, as well as areas that warrant future exploration:

• **Start with many strong examples.** For studying inquiry, our project design worked quite well. But for narrative, we were probably overly ambitious in wanting to study something before we could reliably create it. Trying to apply a particular technique (compelling personal stories) in a novel way (to individual phenomenological science exhibits) required a lot of resources, and led to some of the design tensions described earlier. It might have been preferable to focus our rigorous studies on an exhibit technique with more examples of proven success in our context.

• **Strive for clearer definitions and clearer hypotheses.** Given that the project was exploratory with regard to narrative in the sense just described, we deliberately chose a variety of possible enhancements as well as a wide range of assessments, hoping for success in some dimension of the visitor experience. But in the future we would choose narrower definitions of key concepts (such as narrative, meaning-making, significance), and we would conduct focused assessments to test smaller hypotheses, instead of trying to assess everything at once in a scatter-shot approach.

• **Professional storytellers and other experts should participate earlier.** At the beginning of this project, we had a strong preference for using the authentic, unrehearsed stories of visitors and staff. But, given our finding that authenticity of the speaker seems less important to visitors than the compelling nature of the presentation, we would bring in narrative experts such as storytellers earlier in our process, and include a broader variety of performance-like narratives in our enhancements.

• **Focus on environmental design.** More studies will be needed to determine whether certain types of exhibit environments can increase the likelihood of visitors telling and listening to stories.

• **Design for visitors’ stories.** Finally, we wish we could explore more approaches that inspire visitors to tell their own stories, as well as listen to the stories of others.

We need more solid research studies, studies that are done with the thoughtfulness, discipline, and systematic approach that this study has undertaken. The Exploratorium has done a terrific job of soliciting input, comment and criticism from the field. Not all research projects are willing to do that.

Deborah Perry (2003)
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## INTERVIEW QUESTIONS FOR CUED VISITORS
(Note that the question order is not always sequential; we added and omitted questions over the course of the study, and decided not to renumber them in order to preserve continuity across exhibits.)

<table>
<thead>
<tr>
<th>Question</th>
<th>How it was coded</th>
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<tbody>
<tr>
<td><strong>Preamble:</strong> In these questions, when I say “the exhibit,” I mean everything, including all the (mention exhibit elements), as well as the labels and the video. So everything altogether. Okay?</td>
<td></td>
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<tr>
<td>1  How interesting was this exhibit for you?</td>
<td>Visitors rated from 1–5.</td>
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</table>
| 5  Can you think of any connections between the exhibit and anything else from your own life? (Ask: “Anything else?” until visitor has no more to say.) | Number: The number of different connections visitors made to their lives (0 / 1 / 2 / 3+)

Depth: The maximum depth of connections made (no connection / objects in exhibit / properties of exhibit / causal relations in exhibit)

Personal: Whether visitors included a personal quality, sharing something about themselves in their connections (yes / no)

| 6  Is there anything about this experience that you could imagine using or applying in your life in the future? | Teaching: Whether visitors anticipate using this to teach someone else in their life, such as children (yes / no)

Seeing things differently: Whether visitors anticipate having a new perspective or thinking differently about something in their lives (yes / no)

Doing something new: Whether visitors anticipate actually taking some new action as a result of their exhibit experience (yes / no)

| 7  Was there anything you discovered or figured out while using the exhibit? (Ask: “Anything else?” until visitor has no more to say.) | About exhibit: Whether visitors report discovering or figuring out something related to the exhibit (yes / no)

Beyond exhibit: Whether visitors report discovering or figuring out something about the world beyond the exhibit (yes / no)

| 8  While you were using the exhibit, did you or your group try or think about anything that wasn’t already in the labels or the video? | Tried: Whether visitors reported trying something not already in the labels or video (yes / no)

Thought: Whether visitors reported thinking about something not already in the labels or video (yes / no)

Thought about exhibit: Whether visitors thought about something related to the exhibit (yes / no)

Thought beyond exhibit: Whether visitors thought about something related to the world beyond the exhibit (yes / no) |
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<thead>
<tr>
<th>Question</th>
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<tbody>
<tr>
<td>9 How much would you say the exhibit got you thinking?</td>
<td>Visitors rated from 1–5.</td>
</tr>
<tr>
<td>10 How much would you say the exhibit got you feeling any kind of feelings or emotion?</td>
<td>Visitors rated from 1–5.</td>
</tr>
<tr>
<td>11 How much would you say the exhibit engaged your imagination?</td>
<td>Visitors rated from 1–5.</td>
</tr>
<tr>
<td>12 How much would you say the exhibit took you beyond the museum to the outside world?</td>
<td>Visitors rated from 1–5.</td>
</tr>
<tr>
<td>12.5 IF Group had Children: How much would you say the exhibit labels and videos helped you</td>
<td>Visitors rated from 1–5.</td>
</tr>
<tr>
<td>talk to your child(ren) about the exhibit?</td>
<td></td>
</tr>
<tr>
<td>IF No Children: How much would you say the exhibit labels and videos helped you talk with</td>
<td></td>
</tr>
<tr>
<td>others in your group about the exhibit?</td>
<td></td>
</tr>
<tr>
<td><strong>Video versions only</strong></td>
<td></td>
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<tr>
<td>13 Would you say that having the video made the exhibit: much worse, a little worse, about</td>
<td>Visitors rated from 1–5 (“much worse” to “much better”).</td>
</tr>
<tr>
<td>the same, a little better, or much better?</td>
<td></td>
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<tr>
<td>14 Here are the four different stories/activities on the video. Could you tell me which one</td>
<td>Visitors ranked clips and gave reasons.</td>
</tr>
<tr>
<td>you liked best? What was it about that one that you didn’t like?</td>
<td></td>
</tr>
<tr>
<td>15 Which one did you like the least? What was it about that one that you didn’t like?</td>
<td>Visitors ranked clips and gave reasons.</td>
</tr>
<tr>
<td>16 How was the number of clips: was it too few, too many, or about right?</td>
<td>Visitors rated number of clips (too few / too many / about right)</td>
</tr>
<tr>
<td>17 How was the length of each clip: too short, too long, or about right?</td>
<td>Visitors rated length of clips (too short / too long / about right)</td>
</tr>
<tr>
<td>18 (Only for Narrative version) While you were listening to the videos, did you feel like</td>
<td>Degree to which visitors were negatively impacted by use of actors telling stories</td>
</tr>
<tr>
<td>these were the real people telling their own personal stories or actors going from scripts?</td>
<td>(thought they were real = 0 / thought they were actors but didn’t interfere with</td>
</tr>
<tr>
<td>(If they say actors) Since you knew/had a suspicion/thought maybe these were actors, did</td>
<td>the experience = 1 / thought they were actors and did interfere with the experience</td>
</tr>
<tr>
<td>that make it more difficult to personally relate to the stories?</td>
<td>= 2)</td>
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<td>Question</td>
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| Do you have any professional or personal background that might have helped you understand or relate to this exhibit? (Ask: “Anything else?” until visitor has no more to say.) | Professional: Whether visitors mentioned something in their background related to their professional training (yes / no)  
Life experience: Whether visitors mentioned something in their background related to their life experience (yes / no)  
Emotional: Whether visitors mentioned something in their background that they talked about with an emotional connection such as delight or enjoyment (yes / no)                                                                                                                                                                                                                                                                                                                                                     |
| Follow-up interview questions (about four months later)                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Can you tell me anything you remember doing while you were using that exhibit? (Ask: “Anything else?” until visitor has no more to say.) | Whether visitors remember any specific physical interactions with the exhibit (yes / no)                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Can you tell me anything you remember thinking about, or feeling, while you were using that exhibit? (Ask: “Anything else?” until visitor has no more to say.) | Whether visitors remember any specific thoughts or feelings related to the world beyond the exhibit (yes / no)                                                                                                                                                                                                                                                                                                                                                                                                   |
| Since your visit, has there been anything that’s reminded you of the exhibit for any reason? (Ask: “Anything else?” until visitor has no more to say.) | Whether visitors have been reminded of their exhibit experience in any way (yes / no)                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Has your experience with the exhibit changed the way you look at anything, or think about anything, in your life? (Ask: “Anything else?” until visitor has no more to say.) | Whether visitors report having a new perspective on anything in their lives (yes / no)                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Have you talked about your experience with that particular exhibit since leaving the museum? (If yes) Do you remember what you said, when you were talking together about it? Do you remember when you had that conversation? Was there any other time you talked to anyone about it, either with the same people or someone else? | Talked: Whether visitors report having talked with anyone about their experience with the exhibit since leaving the museum (yes / no)  
Talked about exhibit: Whether the talk was about the exhibit (yes / no)  
Talked beyond exhibit: Whether the talk was about the world beyond the exhibit (yes / no)                                                                                                                                                                                                                                                                                                                                                   |
| Do you remember seeing some video clips as part of the exhibit? (If yes) Can you tell me anything you remember about them? (Ask: “Anything else?” until visitor has no more to say.) | Memory score: Degree to which visitors remember videos (not at all = 0 / existence of videos = 1 / general impressions of videos = 2 / specific content from one clip = 3 / specific content from more than one clip = 4)                                                                                                                                                                                                                                                                                                                                                                    |
| Do you remember anything specific about what the people said in the videos? (If no) Or even the gist of what they said, the basic idea? (Ask: “Anything else?” until visitor has no more to say.) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |