Science Centers and Informal Learning

Science Centers as Learning Environments:
• Defining Our Impact

Initial and Prolonged Engagement:
• Resolving the Tensions

Factors That Shape Vivid Long-Term Memories:
• Issues for Science Centers to Ponder

The Search for Learning Outcomes:
• Beyond the Deficit Model

Outside the Walls:
• New Directions in Family Learning Research

‘Measuring the Immeasurable’
• Museums and Educational Accountability
Research into informal learning, like other types of scientific investigation, is incremental and self-referential. The process may seem opaque to observers; yet over time, consensus emerges and points to promising new avenues of exploration. The content of this issue was informed by three recent initiatives: the October 2004 commissioning by ASTC of a “brief but penetrating summary of the current status of learning in science centers and museums,” resulting in Colin Johnson’s article on page 3; the November 2004 “In Principle, In Practice” conference in Annapolis (see page 14), where museum directors, educators, exhibit designers, and others examined the future of museums through the lens of learning research; and the May 2005 symposium convened by the National Academies’ Board on Science Education (see page 10) to assess “The Status of Research on Learning Science within Informal Education Settings.” The articles here, although only a sampling of the many topics raised and discussed in these forums, offer some key insights into what we currently know about learning in museums and how that knowledge might inform our future work.

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Cover: Analysis of visitor studies at San Francisco’s Exploratorium suggested ways that exhibit developers could turn initial visitor interest into active prolonged engagement. Downhill Race photo by Lily Rodriguez and cover design concept by Diane Burk/courtesy The Exploratorium

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Defining Our Impact

By Colin Johnson

Observers and critics of science centers, science festivals, and other informal learning situations sometimes ask, “They’re having fun—but are they learning anything?”

As Alan Friedman noted in his 2001 article of the same name, the question reflects the culture of schools, where performance—as registered by the many different testing regimes in use around the world—is geared to the achievement of predetermined targets and driven by a preimposed curriculum.

Science centers, by contrast, typically impose no curriculum, and the learning pathways followed there are normally determined by the learners themselves. Mapping the achievements of museum visitors thus depends on recognizing the destinations that are reached along a pathway—and on understanding that the journey and the destinations are equally significant.

There are no tests in science centers, and as Frank Oppenheimer, founder of the Exploratorium, famously remarked, “No one ever flunks a museum.”

What do we mean by ‘learning’?

Some have argued that learning is learning, whether acquired formally or informally. In many educational institutions, learning has been traditionally defined as the retention of factual information. Instructional approaches based on this view emphasize delivery, rather than engagement, on the assumption that the learner will take on board an appropriate selection of what is offered.

In contrast to this “transmitting teacher/passive learner” ethos, science centers and museums (and, to be fair, some schools) have adopted a view of the learning process that regards the learner as an active participant in the “construction” of new knowledge and understanding. Educational programming in museums celebrates the individual, provides opportunities for that individual to construct his/her own learning pathway, and allows for a multitude of outcomes from each encounter.

“Informal learning” (as opposed to “formal,” or “classroom,” learning) is the term that has come to mean the kind of learning that occurs in museums and science centers, or as a result of museum experiences. When we use this term, it is important to stress that we are speaking of a process as well as an outcome. Researchers have recognized and described this informal (sometimes called “nonformal”) process in a number of ways.

Among the first to examine the learning process in detail were...
Benjamin Bloom and David Krathwohl, who in 1956 proposed a “taxonomy of learning objectives” within three domains: cognitive (knowledge with understanding), psychomotor (practical skills), and affective (motional and ethical aspects). In each domain, they said, the learner pursues the same types of goals: “knowledge, understanding, application, analysis, synthesis, evaluation.”

This view of learning as process has continued to inform research into informal learning:

- Chantal Barriault, observing museum visitors in 1998, described a sequence of “initiation, transition, breakthrough,” with a set of eight associated learning behaviors (see sidebar, page 5) that lend themselves to use as an assessment tool.

- In 2001, Dorothy Williams and Caroline Wavell, working in school libraries, saw the process as “motivation, progression, independence, interaction.”

- Bonnie Sachatello-Sawyer and Robert Fellenz, writing about adult learning in 2002, described a process moving from “knowledge and skill acquisition, expanded relationships, and increased appreciation or meaningfulness” to “changed attitude or emotion, transformed perspective, and life-changing experience.”

- In 2003, Eileen Hooper-Greenhill and her University of Leicester team formulated a system of “generic learning objectives” (GLOs), not necessarily sequential, that breaks visitor experiences into codeable categories (see “Generic Learning Outcomes: An Assessment Framework,” page 12).

However we describe it, the informal learning process mirrors everyday life much more closely than does the formal teaching/learning situation. It can be seen in an infant’s earliest exploration of his or her surroundings and in every visit an older learner makes to a library, a symphony concert, or even a football game. Its choices inform the entire world of play. It is a process that human beings undertake not only willingly, but with conspicuous success.

**Environments for learning**

To document what happens in the informal learning environment, or ILE, of a science center is challenging because the evidence for learning outcomes is not often seen at the same time as the experience. This is not, as some might argue, a limitation on the work of science centers, but rather an indication of its power. Science centers offer a unique range of life-enhancing experiences and potential insights, through which each visitor is able to assemble a personal databank for later consultation.

What constitutes a “learning environment”? Researchers John Falk and Lynn Dierking, preferring the term “free-choice learning environment,” describe a model (see www.ilinet.org) that encompasses three key “contexts for learning”—personal, sociocultural, and physical:

- **Personal context**, they explain, “describes all the personal characteristics that a person brings to a free-choice learning situation, including his or her interests and motivations, learning style preferences, prior knowledge and experience—each very critical components of successful experiences (and learning). Motivation and emotional connection also play an important role in this context.”

- **Sociocultural context** encompasses factors that recognize that learning is both an individual and a group experience. What someone experiences and learns, let alone why and how someone engages in such experiences, are inextricably bound to the social, cultural, and historical context in which that experience and learning occur.... More often than not, free-choice learning experiences are shared experiences, opportunities for collaborative learning.”

- **Physical context** includes not only “rich physical environments, filled with many real-world objects and connections that help to meaningfully contextualize presented concepts/ideas,” but also “factors that transcend the specifics of the learning situation. The architecture and ‘feel’ of a building or natural setting, the way learners are oriented, the design features that guide learners through the experience, and the sights, sounds, and smells, also strongly influence free-choice learning.”

Each context, Falk and Dierking conclude, contributes to and influences visitors’ interactions and experiences in a different way.

Beyond the exhibit galleries, other areas of the museum are designed for experiential learning through educational programs. Little research has been done on these settings, which range from laboratories, workrooms, weather stations, and computer labs to discovery rooms, demonstration theaters, libraries, and planetariums.

A sampling of the educational activities and interactions such venues make possible include debate and discussion; consultative and deliberative inquiries (including consensus conferences); theatrical encounters, involving both actors and demonstrators; meetings with professional and amateur scientists; real-time observation of the scientific process; and science clubs and related activities.

**The social context**

A visit to a science center is much more than an encounter with physical phenomena. It is also an opportunity for social interaction and self-expression, both linked to learning.

People generally visit science centers in groups (families or prearranged parties), and the visit often involves a good deal of shared experience and conversation. Articulating an experience and the associated ideas that flow from it is an important mechanism for understanding. Conversation among group members provides a hierarchy for learning that builds from observation (“Did you see ... happening?”) via contextualization (“That reminds me of ...”) to interpretation (“I think that’s because ...”).

Science centers also have much to offer in the field that is variously called “science in society” or “science and citizenship.” Worldwide, we see
adoption of the Café Scientifique idea, where guests meet in a social environment, such as a bar or café, to hear an introductory talk on a scientific topic and then engage in debate with the speaker and one another.

Many science museums now animate their galleries with “people to talk to”—active or retired scientists perhaps, or even character actors with a well-rehearsed brief. Examples range from the Cardiac Classroom videoconferencing program at New Jersey’s Liberty Science Center to Meet the Scientist, a U.K. program in which the museum becomes a forum where researchers can engage in dialogue with the general public.

That the public considers science worthy of attention is confirmed by a 2000 baseline study from the U.K.’s OST/Wellcome Trust, which identified a range of underlying attitudes toward science within the British population in terms of six categories: Confident believers (17 percent), Concerned (13 percent), Not sure (17 percent), Technophile (21 percent), Supporters (17 percent), and Not for me (15 percent). The area of public understanding of research (its content, methodology, and implications) has also been studied extensively in the United States. A 2004 book by David Chittenden and others, Creating Connections: Museums and the Public Understanding of Current Research, summarizes some of this work as it pertains to the field.

Conclusion

Museum research offers strong evidence that science centers and museums provide motivating and enriching settings for informal learning. These “free-choice” environments strongly engage the attention of learners and allow for responses appropriate to their individual backgrounds. Immediate impact can be exciting, but slow-burn effects on learning and motivation may be even more significant. The challenge is to document those effects when there is an extended time period between the experience and the contexts in which it is applied.

Museums and science centers also support social engagement, particularly through the educational role of parents and teachers. An important opportunity provided by science centers involves “talking to learn.” Conversation—with family members, peer groups, or museum staff—leads to the kind of articulation of ideas that is at the very heart of assimilation. Similar self-directed social learning opportunities are not readily achieved in schools.

Learning in science centers and museums also takes place in a wider context than that of the classroom. It begins with the learner’s prior experience and expands to take in the interactive opportunities and, most importantly, related programming activities provided by the center. Both teachers and students gain from the process.

Finally, science centers are widely perceived as neutral venues for discussion, consultation, and deliberation. Unfettered by political adherence, and independent in relation to the scientific community as a whole, they are appropriate settings for ongoing learning by adult audiences. Governments and major educational trusts across the world are becoming increasingly aware of these potential benefits.

Consultant and former ASTC board member Colin Johnson (colinh.johnson@nthworld.com) was director and CEO of Techniquest, Cardiff, Wales, from 1997 to 2004. An extended version of this article can be found at www.astc.org/resource/education/johnson_scientests.htm.

A Tool for Measuring Learning

In the late 1990s, Science North staff scientist Chantal Barriault, while pursuing a master’s degree program in science communication, closely studied the actions of visitors at Techniquest, in Cardiff, Wales, and at her own institution in Sudbury, Ontario, Canada. Her 1998 report outlines the naturalistic methodologies she used, including a grounded theory approach to data collection and analysis. These investigations culminated in an initial framework that identifies eight learning behaviors associated with a rich visitor learning experience in order of increasing levels of engagement:

Initiation behaviors:

- Watching others engaged in the activity
- Receiving information offered by staff or other visitors
- Doing the activity

Transitional behaviors:

- Showing a positive emotional response
- Repeating the activity

Breakthrough behaviors:

- Relating the new experience to past experiences
- Seeking and sharing further information
- Becoming fully engaged and involved in continued investigation

The study concludes that this framework can be an assessment tool for science center professionals to better understand the nature of their visitors’ learning experiences, as well as a guideline for exhibit and “experience” designers looking to increase the opportunities for visitors to engage in the various learning behaviors.

**Initial and Prolonged Engagement:**

**Resolving the Tensions**

By Joshua P. Gutwill and Erik Thogersen

A primary goal of the Active Prolonged Engagement (APE) project at the Exploratorium was to build exhibits that could be approached and immediately used by visitors to create an intriguing, beautiful, or enjoyable experience reasonably quickly. But after captivating visitors, we wanted the exhibit to be sufficiently complex to encourage continued exploration in deeper ways. This combination of initial engagement and prolonged engagement would, we felt, provide the foundation for an APE experience.

Our notion at the beginning was that prolonged engagement seems to require that the exhibit offer several options or features for visitors to manipulate and explore. In contrast, initial engagement seems to require a limited number of options, so that visitors are not overwhelmed with choices. Our concern was to find the sweet spot between too few options and too many.

**Creating reliable entry points**

What we discovered is that the tension between initial and prolonged engagement arose from our own misunderstanding of the two processes. Initial engagement does not require a single starting place; rather, it requires that any starting place provide a reliable entry to the exhibit experience. APE exhibits benefit from having as many reliable entry points as possible.

Creating reliable entry points requires good label design; better yet, it requires good affordances. Donald Norman has defined affordances as “the properties of objects—what sorts of operations and manipulations can be done to a particular object. A door affords opening and closing; a doorway affords passage.” Visitors need to be able to use an exhibit without much instruction; they should know how to manipulate its parts to get an experience going. Whether they start in one place or another is not important.

Unfortunately, “good affordances” is a design feature that cannot be defined a priori: We can only know that exhibit affordances are obvious to visitors by watching visitors use them. APE exhibit developers discussed specific techniques of creating affordances that are usually clear to visitors, but formative evaluation is required to be sure that visitors can get started easily.

Still, the developers evolved rules of thumb that were helpful and important in building exhibits that led to strong initial engagement:

- Graphics should be placed where visitors need them, but should still have a hierarchy that makes it easy to see where to start.
- Clear, active exhibit titles can quickly orient visitors.
- Those parts of an exhibit that can be manipulated should provide quick and discernible feedback indicating that they have been manipulated.
- Large features will often be used first and vigorously, but small features are often treated delicately and may not be noticed—so controls should be scaled according to how you hope they will be used.
- Cranks with handles are for vigorous turning, and cranks without handles are for smaller adjustments.
- Buttons should operate predictably, and their functions should be clear (we try to use buttons that light up to indicate their active modes).
- Benches and low tables encourage visitors to sit down; high tables encourage them to stand.

**Prolonging engagement**

After visitors figure out how to get started, something interesting must happen to motivate their deeper engagement. This might seem obvious, but we tried to set particularly high standards for APE exhibits. Many of the Exploratorium’s classic exhibits provide rewards for interaction, but they seem mainly to satisfy visitors with an interaction holding time of 60 seconds or so. APE exhibits needed to motivate visitors to keep going, to...
see what else they could do. At the project’s beginning, we thought that simply adding more options and controls to exhibits with strong initial engagement would make them APE-y, as long as we didn’t ruin that initial engagement. However, prolonged engagement seems to require several options leading to multiple intriguing outcomes.

In our most successful APE exhibits, the options are related so that one can at least imagine a sequence of interactions between visitor and exhibit that build, one from the next. We called this the visitor’s “path” through the exhibit. In the best cases, we can imagine a large variety of paths, thus allowing for multiple entry points and multiple outcomes.

Like initial engagement, strong prolonged engagement also requires sustained positive feedback: Each time the visitor interacts with the exhibit, there must be feedback telling the visitor that the exhibit is responding. Ideally, those responses would further intrigue visitors and prompt them to continue exploring, constructing, observing, or investigating.

Two design approaches we tried and tested seem particularly powerful in providing good initial engagement while also encouraging prolonged engagement. The first is to break an exhibit into multiple stations. By taking an exhibit with an open-ended, multiuser interface, such as Spinning Patterns, and creating multiple stations that contain the same components, we allowed several visitors to use the exhibit simultaneously while still giving each person control over his or her experience.

The second design approach is to pose challenges in the exhibit graphic text. We found that challenges served to focus visitors’ attention on a subset of the options—those required to meet the challenge—while still conveying the notion that there are many other activities to try. At the 3-D Shapes exhibit, for example, visitors read any one of eight challenge cards, such as “Make a soccer ball,” which challenges visitors to build a soccer ball using only the hexagon and pentagon elements. This activity offers a concrete, real-world application of the materials without minutely prescribing the steps visitors should take to build objects.

Joshua P. Gutwill is a senior researcher for visitor research and evaluation and Erik Thogersen is an exhibit developer at the Exploratorium, San Francisco, California. This article and its sidebar are excerpted from Fostering Active Prolonged Engagement: The Art of Creating APE Exhibits, by Thomas Humphrey, Joshua P. Gutwill, and the Exploratorium APE Team (Exploratorium, 2005); available from ASTC Publications at www.astc.org.

### Spinning Patterns: An APE Tale / By Charles Sowers

The Spinning Patterns exhibit started its life as a lapping tool, built and used in the 1940s by the California Academy of Sciences to grind prisms for tank periscopes. Alan Wilson, a former exhibit developer at the Exploratorium, acquired the tool in the 1980s. Noticing the circular, spiral, and cardioid patterns that resulted from running a finger across its rotating lap wheel, he covered the wheel with particleboard, added a sand tray, and put the tool on the museum floor as an exhibit.

In 2000, I modified the exhibit, lowering it from 36 inches high to 27 inches and making it circular, with nearly 300-degree access. At first, this rebuild seemed to be a strong improvement... [The exhibit] got more use, and people seemed to be staying for relatively long periods of time. However, it soon became obvious that few people were creating any sort of recognizable patterns; ... as one person drew on the spinning plate, he or she altered or obliterated someone else’s drawing.

We experimented with a few graphic approaches [and with limiting] the number of visitors trying to draw at the same time, but our efforts were stymied by the exhibit’s considerable attracting power.... These experiments made it clear to us that a better design for the exhibit would have several spinning platforms so that several visitors could use the exhibit simultaneously without interfering with one another. I then asked an Exploratorium intern, Elisa Morua, to work out a plan for a three-station version of the exhibit.

We made it so that each platform accommodates only one person; high Plexiglas barriers prevent other visitors from interfering with the users seated at the three spinning tables... [and] we created an exhibit graphic that offers parents questions to pose to their children and suggests various techniques for making patterns....
As a part of my ongoing research into the psychology of long-term memory associated with visitor experiences, I conducted a study in 2004 examining the memories of visitors who had been to the 1970 Osaka World Exposition in Japan (Expo 70).

I have been using the cases of visitors’ experiences at world expositions to better understand the kinds of episodic experiences that subsequently become deeply encoded and develop as memories that are highly vivid years later. Part of the research work focuses on developing theoretical models that could describe why, and how, some kinds of life experiences remain vivid years later.

Needless to say, this is not a straightforward question, and the psychological explanations are complex. But because world expositions, like science centers, generally consist of a collection of themed exhibitions, and many of those exhibitions are built by the same people who design and build exhibits for museums, the outcomes of this study have some interesting implications for the science center field. Expositions simply provide a more convenient chronological place-marker and source of rich experience for memory research.

A range of experiences

Expo 70 was an extremely successful international event. Spread over 865 acres, the Osaka exposition attracted 64 million visits between March and September 1970. For my study, I conducted interviews in Japan with Japanese nationals who had visited the site at the time.

The interviews were conducted individually and face-to-face, with the average session lasting about 45 minutes. Each interview probed both spontaneous and cue-stimulated memories of the Expo 70 visitors, in search of events and episodes that they might recollect 34 years after the event.

The interviewees included a wide diversity of people, among them people who were businessmen, housewives, and students at the time of the Expo. They ranged in age from those who were just 7 years old in 1970 to those who were in their 50s. Some indicated in the interview that they were going through difficulties and challenges in 1970, while others said they were happy and fulfilled in life at the time. All of these factors had relevance to the persistence and subject matter of memories.

The kinds of experiences that interviewees recalled most vividly were also diverse. Some gave highly detailed descriptions of specific episodes and/or sequences of events that occurred on specific days of their visits to Expo 70. For example, a number recalled the minutiae of packing lunches to take to the exposition—usually because they had heard that the site would be crowded and that it would be difficult to get into the cafes and restaurants.

Some recalled the joys and surprises of seeing exhibits such as the Moon Stone, which had been retrieved from the Apollo 11 mission just eight months earlier. Others had unhappy memories of the Expo, involving frustration with the crowds, or the trauma of losing a child, or regret that they were not able to see specific
exhibits that they had wanted and planned to view.

**The white tiger**

Among the many interesting stories and memory episodes was the case of a woman I call “Mrs. Tomoko.” Amid the general excitement over the Expo, she recalled, all the newspapers were running stories about the white tiger in the Indian Pavilion. This was a feature exhibit of an animal named “Dalip,” one of only 33 such tigers existing in the world at the time.

Mrs. Tomoko told of reading about the tiger in the newspaper and from other sources and making plans to visit the Indian Pavilion. She then described her vivid memory of actually seeing the animal.

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**One of the memories that sticks with me the most is the Indian Pavilion…. We had read in the newspaper that there was a White Tiger exhibit. So, we were able to see it and it was so wonderful—although it wasn’t completely white! The newspaper had called the White Tiger “God’s Tiger-Dog” [God’s pet]. Even now I can remember it perfectly. Even though the newspaper said it was white, it was more of a yellow shade. The White Tiger was in a cage, and the onlookers were about two meters away all around the cage. It wasn’t a circular configuration—it was only along two sides of the cage, and inside there was one animal. So there was one large space devoted to this exhibit. The tiger is my most memorable experience of the Expo.”—Mrs. Tomoko, recalling the 1970 Osaka World Exposition

As Mrs. Tomoko told her story during our interview, her body language expressed some of her delight in seeing this rare specimen. Her gestures and her gaze conveyed a rapturous wonderment and appreciation at the recollection of the episode. She also drew a small sketch of the pavilion and illustrated the position of the tiger cage and the flow pattern of the path that she took as she viewed the animal.

Other similarly detailed recollections emerged from this study, but in this instance I theorize that the vividness of Mrs. Tomoko’s memory of this episode is accounted for in several ways:

- First, her memories of experiencing the White Tiger exhibit are characterized by strong positive affect. It was a highly aesthetic experience that even to this day brings back pleasant memories as she recalls and relives the experience 34 years past.
- Second, there was strong evidence that Mrs. Tomoko had revisited this memory in a reminiscing manner on a number of occasions since the experience.
- Third, Mrs. Tomoko clearly pre-planned to see this exhibit before coming to Expo 70. There is evidence from the transcript about the effort she made to read about this exhibition in the newspaper and other media, and about how she was subsequently motivated to intentionalize the visit to the Indian Pavilion, expressly with the purpose of seeing “God’s Tiger-Dog.”
- Finally, I believe that this planned agenda was fulfilled beyond the expectations of Mrs. Tomoko and resulted in very strong positive affect. The memory vividness is strongly encoded and reflects the impressive impact of the episode even decades years later.

**Implications of the research**

In my subsequent statistical analysis and modeling of more than 120 memory events of people I interviewed regarding Expo 70, I determined that there are four interrelated factors that seem to be key to the development and retentions of vivid memories 34 years later. These include:

1. **Intentionality**—planning to do or see something at the Expo;
2. **Agenda fulfillment**—the degree to which planned agendas were fulfilled or frustrated;
3. **Experiential affect**—the extent of positive (or negative) emotion that was associated with the event or episode; and
4. **Rehearsal**—the degree to which the memories of the event were subsequently relived and brought back to memory over the years.

Assuming the outcomes of this new research are generalizable, then there may be some lessons here for science centers as they think about how they might maximize the impact of visitor experiences. Put very simply, I think there are four questions science centers might ask themselves:

- How can we get visitors to intentionalize their visitation experiences in both general and specific ways?
- How can we help visitors to realize and even surpass their planned intentions?
- How can we both maximize the positive affect associated with science center experiences and minimize the potential for negative experience?
- And finally, how can we help visitors to revisit their experiences in the days and months following their visit?

Based on my research, the effort to raise and answer these questions in the planning process might go a long way toward helping science centers design truly memorable and long-lasting learning experiences for their visitors.

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INFORMAL SCIENCE LEARNING RESOURCES

The following entries represent references and other resources cited by contributors to this issue.

Recommended readings

- Chittenden, David, Graham Farmelo, and Bruce V. Lewenstein (eds.). Creating Connections: Museums and the Public Understanding of Current Research. Walnut Creek, Calif.: AltaMira Press, 2004.

Online resources

National Academies Board on Science Education (BOSE) www7.nationalacademies.org/bose/index.html
Several ASTC representatives wrote “think pieces” or participated on panels for a one-day meeting on “The Status of Research on Learning Science within Informal Education Settings,” convened by BOSE in Washington, D.C., in May 2005. To access the agenda and posted articles, click on “BOSE Projects.”
Center for Informal Learning and Schools (CILS) www.exploratorium.edu/cils/
A collaborative effort of the Exploratorium, the University of California–Santa Cruz, and King’s College London, CILS supports research and develops leadership in the study of informal science learning and institutions and their relationships to schools. Resources on the site include a projects portfolio and a comprehensive reading list.

Informal Science
www.informalscience.org
A comprehensive resource for the latest research and techniques to encourage the learning of science in everyday life.

Inspiring Learning for All
www.inspiringlearningforall.gov.uk/
This Museum, Libraries, and Archives (MLA) web site includes details on the GLOs model. (See “Generic Learning Objectives: An Assessment Framework,” page 12.)

Learning in Informal and Formal Environments (LIFE) Center http://life-slc.org/
The web site for a new five-year, $12.4 million National Science Foundation–funded project, based at the University of Washington, Stanford University, and SRI Inc., that seeks to develop cross-strand “generalizable interdisciplinary theories that can guide the design of effective new technologies and learning environments.”
D o science centers increase public understanding of science? I have always thought so, even though the premise is hard to prove. Frank Oppenheimer thought so, too. In 1968, he included the following in a C a n t o r article about his rationale for creating the Exploratorium:

*There is an increasing need to develop public understanding of science and technology. The fruits of science and the products of technology continue to shape the nature of our society and to influence events which have a worldwide significance. Yet the gulf between the daily lives and experience of most people and the complexity of science and technology is widening.* (Vol. 11, No. 3).

Science centers, Oppenheimer believed, would help bridge this gulf. But have they? Although hundreds of science centers have opened since the Exploratorium was launched in 1969, the gap still seems wide as we attempt to communicate about biotechnology, nanotechnology, and other sciences that didn’t even exist in the 1960s. The National Science Board’s 2005 report on the public’s level of “scientific literacy”—defined as “knowing basic facts and concepts about science and having an understanding of how science works”—shows little change from the results of the late 1980s (with the possible exception of increased awareness that antibiotics do not kill viruses).

Are our institutions failing to raise public understanding of science? Or are we not evaluating our performance correctly? Either way, we need to do better.

**What do visitors say?**

Most museum professionals believe strongly that science centers have a positive effect on the public’s understanding of science. They just don’t like the standard way of measuring it.

To start with, they point out, there’s the term “science literacy” itself, which implies that there is some general level of knowledge to be gained and some general test to apply, on which a passing grade would render one scientifically literate. Yet despite their objections, testing is the way some researchers have approached this issue for years, as in the National Science Foundation “Indicators” surveys, which ask the public to define basic scientific concepts, such as molecules or plate tectonics, and then compile the results.

Eight years of work on education programs in a science center have taught me that this “deficit model” just isn’t helpful. Most people aren’t coming to museums to have their science deficits replenished—but they are coming to learn. To illustrate, I cite some data I collected in 2002 from visitors to *Titanic: The Artifact Exhibition*, when I was a researcher at the Arizona Science Center.

*Titanic* is an extremely popular exhibition that continues to tour many U.S. centers. In Phoenix, it received 320,000 visitors, 34,000 of whom wrote comments in a loose-leaf (and content-replaceable) binder stationed prominently at the exhibit exit. This was part of an evaluation that included visitor observations, an analysis of media coverage, and surveys of visitor experience, satisfaction, and enjoyment.

The comments book had the simple aim of prompting visitors to share their immediate responses. At the top of each page was the invitation: “Please share your thoughts.” It’s impossible to give a complete sense here of what these contained, but one can gain a flavor from a few examples:

> Definitely worth the time and money even though we have all been deluged with “Titanic-mania” all these years. It’s great to hear the story and see all the artifacts in this most moving way. A definite tribute to all who died and lived at that far distant time.

> I loved the sound and the sense of actually being on the ship. The grand staircase was amazing! ...Through gaining an identity of one actually on the ship, I gained an attachment and hope towards my identity living. Thanks for a great insight!

> Wonderful, makes you want to go to the library and find out more about your person. It was like you were actually there walking through the ship (through time), until you hit the end.

> …and I survived the Titanic; it was a great experience, well put together. I was very surprised to see a brother. I had no idea black passengers were allowed on the ship, white wife or not.

> Titanic shall always be the most dramatic manifestation of man’s arrogance and defiance to life, fate, and God’s will and sovereignty.
These and thousands of other comments told me that visitors did learn a great deal at the exhibition, but more often about themselves than about the science or history of the Titanic per se. They demonstrated that learning is personal, unpredictable, idiosyncratic, context-dependent, and provisional. This kind of data can’t be captured with a multiple-choice survey focused on facts; it requires a more qualitative approach.

**Bridging the quantitative/qualitative gap**

The attempt to assess science learning in the broader “context” of not only factual knowledge but also social, psychological, and political factors has been adopted and explored by many researchers and has proved useful in understanding learning in general—and, one should add, science learning in science centers in particular.

But the “contextualist” approach still hasn’t helped to answer the big question: Have science centers had a positive and negative attitudes in relation to an experience. They demonstrated that learning is affected more by the context of political knowledge than by the context of political knowledge.

By integrating contextualist and deficit perspectives, the authors write, “we hope to open up a more open and fruitful dialogue between researchers in the field...We are convinced...that a ‘contextualist’ theoretical perspective.”

Because the model is based on a view of learning as personal and context-dependent, diverse methods of data-gathering can be used. In the UK pilot, concluded in 2004, the 15 participating organizations analyzed user comment cards, held focus groups, and conducted contextual and longitudinal tracking of outcomes, while remaining sensitive to new understandings of what counts as learning.

If we can pull this off, we may learn some useful and exciting things about science learning outcomes, and be able to show that Frank Oppenheimer’s hope is being fulfilled by the institutions he helped invent.

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**Generic Learning Objectives: An Assessment Framework**

Under the direction of professor Eilean Hooper-Greenhill, the Research Centre for Museums and Galleries (RCMG) at the University of Leicester, U.K., developed a toolkit that uses a model called “Generic Learning Outcomes” (GLOs) to measure learning in museums, libraries, and archives. Funding for the project was provided by Resource UK (now the Museums, Archives, and Libraries Council, or MLA).

In the GLO model, individual learning experiences of all kinds—creative, intellectual, social—are organized into the following five major categories, with some further subcategories:

- **Knowledge and understanding**: learning facts, making sense of something, deepening understanding, making links and relationships between things, knowing how museums operate.
- **Skills**: being able to do new things, such as reading, thinking critically, making judgments (intellectual); locating, evaluating, and using information (information management); meeting people, sharing, teamwork, (social); recognizing the feelings of others, managing feelings (emotional); writing, speaking, listening (communications); running, dancing, making (physical).
- **Attitudes and values**: feelings and perceptions, opinions or attitudes about oneself or others, empathy, increased motivation, positive and negative attitudes in relation to an experience.
- **Enjoyment, inspiration, and creativity**: having fun, being surprised, innovative thoughts and/or actions, creativity, exploration and experimentation, being inspired.
- **Activity, behavior, and progression**: what people do, intend to do, and have done; reported or observed actions, a change in the way people manage their lives.

Because the model is based on a view of learning as personal and context-dependent, diverse methods of data-gathering can be used. In the UK pilot, concluded in 2004, the 15 participating organizations analyzed user comment cards, held focus groups, employed observational studies, administered surveys, and reexamined existing data sources for evidence of GLOs. Their results, detailed in an RCMG report, *What Did You Learn at the Museum Today?*, have inspired other museums to adopt the model. At least one pilot site (the Imperial War Museum) attributes its success in gaining new government funding to evidence of visitor learning provided through the framework.

By creating a common language for talking about learning, the GLO system can enable institutions to report, aggregate, and compare learning outcomes at the sector level (all science museums, for example). In addition, the system promises to be useful for those seeking to communicate with schools about the learning impact of museum programs. For more details, visit www.inspiringlearningforall.gov.uk.—R.T.
Outside the Walls:

New Directions in Family Learning Research

By Kirsten Ellenbogen and Kevin Crowley

In an environment of shrinking resources and calls for greater accountability, leadership often finds itself in the position of needing to justify the existence of museums. Why should society, faced with limited resources for education, be committed to the relatively expensive proposition of underwriting informal learning environments? What is the value of the museum experience, compared to a classroom lesson, web site, video, or educational toy covering the same content? What are the unique types of learning that museums support?

Many elegant arguments about the role of museums have been made in response to such questions, and case studies often include stories of scientists pointing to the pivotal museum moment that started their career. But few, if any, of these arguments have been based on what the rest of the educational world is coming to consider credible experimental evidence. Museum leaders need a foundation of studies that answer questions about the credibility of museum studies and provide evidence that can be generalized.

The limits of museum-based research

Much of what we know about learning in science centers comes from evaluation studies—assessments of whether an exhibit or program has been “successful” according to a museum’s stated objectives. A good deal of this work has focused on ways to conceptualize and assess the museum learning experience by interviewing or observing people within the museum.

Researchers have typically addressed important questions about signage, interpretive and interactive exhibit features, the display of objects, or other issues specific to the design of exhibits or programs. Because of explicit, pragmatic goals (or a lack of resources), most evaluation is limited to these sorts of “within-the-walls” outcomes. This body of work is effective in helping developers devise better strategies for achieving exhibit/program outcomes like increased time in exhibitions, rich talk among visiting groups, and stronger concept change.

But what would our studies look like if we were truly able to take a visitor-centered perspective? Some studies do this by assessing visitors’ motivations and how those motivations impact their learning experience at the museum. In carrying out our work, we are often limited by the singularity and short-term nature of the project, yet it is clear that visitor learning does not begin and end with a single museum visit, or even multiple visits.

Over time there have been significant efforts to determine how independent variables, such as prior knowledge, interest, and motivation, individually and collectively impact within-the-walls learning outcomes. There have also been efforts to understand the long-term impact of museums by going outside the walls to talk to visitors months, and even years, after their experience. Examples include David Anderson’s studies on long-term memory among world exposition attendees (see page 8), John Falk and Martin Storksdieck’s L.A.S.E.R. project, or Kirsten Ellenbogen’s work following families across environments, over time. We remain, however, without an answer to the question of how we can provide the practical evidence developers need to refine their work to meet outside-the-walls outcomes, such as creativity, problem solving, and increased interest or affective connections over time.

Three facets of museum learning

Understanding a person’s learning experiences is a comprehensive effort that requires crossing boundaries and integrating multiple learning environments. Museums are just one part of a learning infrastructure that includes schools, libraries, theaters, recreation programs, religious organizations, and other community-based resources. It becomes critical, therefore, to understand the mediating techniques people use in shared learning experiences, and how these experiences fit the larger learning context.

In the last decade, the field has moved rapidly past old dichotomies that describe museum experience in terms of constructing school-like knowledge vs. affective or motivational responses. Drawing on educational theories that approach learning as intrinsically social and grounded in cultural practice, many investigators now view museum learning through a sociocultural or sociocognitive lens, particularly in the context of the family group—the largest segment of the science center audience.

The details of particular studies vary, but much recent work (including that of the present authors, as well as Gaea Leinhardt, Karen Knutson, Maureen Callanan, Lynn Dierking, John Falk, Scott Paris, Doris Ash, and others) supports the notion that museum learning involves at least three interrelated facets:

1. Knowledge is the declarative and conceptual content that people learn—including, for example, facts, theories, concepts, and narratives. This facet of learning is perhaps the most familiar kind of outcome assessed in museum learning research, often through visitor interviews or surveys.

2. Talk refers to a person’s ability to weave disciplinary content into conversations, to construct arguments and
In Principle, in Practice: A Learning Innovation Initiative

By John H. Falk and Lynn D. Dierking

In November 2004, the Institute for Learning Innovation, with support from the National Science Foundation, hosted an international meeting in Annapolis, Maryland, for approximately 90 professionals broadly representative of the museum community.

Participants in the two-day In Principle, In Practice forum included directors, curators, educators, exhibit designers, researchers and evaluators, university professors and students, funders, and policy makers from the United States, Australia, Canada, and Europe. They came from large and small science centers, zoos, and aquariums, and art, history, cultural, ethnic, children’s, and natural history museums. The gathering was a major part of a three-year effort to examine the future of museums through the lens of the past decade’s learning research.

Attendees prepared by reading background papers on museum learning published in a July 2004 supplement to the journal Science Education (Vol. 88). In Annapolis, they labored to define the research issues they thought most pressing, focusing on topics directly related to museums (broadly defined) and to learning (also broadly defined).

The result was a far-reaching, diverse dialogue that included calls for greater relevance and more research, along with pleas for better and different strategies for documenting institutional success:

• One set of conversations centered on the role of the museum as a cultural institution. Major themes included the moral and social responsibility of museums; how to integrate multiple belief systems, voices and perspectives into museum practices; and how to redefine institutional relevance in light of this broad mandate.

• Another round of conversations examined the role of museums in society and considered the implications for practice in terms of fostering partnerships between museums and other cultural institutions, and inventing new models that move beyond mass production to increasingly personalized experiences.

• There was also, given the meeting’s focus, considerable discussion about museums as learning laboratories. Groups pointed out the need for integrating learning theory, research, and practice, for examining and supporting socially mediated learning, and for documenting the long-term impacts of museum experiences. Many felt it was important for museums to integrate learning into the culture of organizations, and to minimize disparities between the educational goals of museums and the realities delivered.

Initial two-page briefs from the Annapolis meeting were posted on various e-mail lists and the Institute’s web site. At a follow-up town hall meeting, held in conjunction with the May 2005 American Association of Museums annual meeting in Indianapolis, a subset of the issues was presented and again debated.

The next step is to formalize the resulting issue statements into two published documents. The first, Insights, will be a series of about a dozen short papers devoted to some of the more practical issues raised by the meeting, such as negotiating school-museum relationships, addressing the challenges of current science, and more actively involving visitors’ voices, particularly those of children, in the design and planning process.

Insights will not attempt to resolve or answer these issues, but rather provide a foundation for addressing them and fostering further discussion. Final Insights papers should be available on the Institute for Learning Innovation’s web site in late 2005.

The second publication will be an edited book, to be published by AltaMira Press in late 2006, that will address some of the weightier, longer-term issues raised at the In Principle, In Practice meetings. Among these are the role of institutions in fostering social change and the need for developing new research and evaluation paradigms. The book will provide appropriate ways to deal with these issues in a more substantive and measured way, and will also include revised versions of the background papers published in Science Education.


John H. Falk and Lynn D. Dierking are director and co-director, respectively, of the Institute for Learning Innovation, Annapolis, Maryland.

Kirsten Ellenbogen is director of evaluation and research in learning at the Science Museum of Minnesota, St. Paul; www.smm.org.
Kevin Crowley is director of the University of Pittsburgh Center for Learning in Out-of-School Environments (UPCLOSE); http://upclose.lrdc.pitt.edu.
thoughtful recent discussion on ASTC’s ISEN-ASTC-L e-mail list addressed the comparative value of science exhibitions that offer free exploration (e.g., inquiry) versus those that deliver accepted wisdom. My own observation is that, whatever our intentions, visitors will construct their own exhibitions out of the hardware, environment, and people they find when they arrive.

Museums may fret about the balance we are attempting to establish, but visitors create their own balance. Indeed, the very definition of informal learning has been that visitors set their own agenda. We cannot control whether they use our exhibitions for play, or for acquiring specific knowledge from authorities, or for something else entirely. I have seen tightly didactic exhibitions used for pure fun (“Come look at this thing—it’s so cool, whatever it is!”) and art pieces with no explicit learning goals used by visitors as structured, constructivist learning tools (“Now I think this is about centrifugal force, because it is trying to show you that...”).

This belief biases me toward exhibitions with real phenomena, regardless of the inquiry vs. didactic balance, because these exhibitions have something real to share, no matter how visitors choose to use them. Simulations worry me, because I find visitors too often focused on the artifacts and compromises of the simulation, which may have no relation to whatever is being simulated or to the rest of the universe. I think exhibitions need a high “reality quotient.”

These issues are often raised in the context of accountability, especially when museums promote themselves as “an important part of the formal education system.” That stance runs the risk of tying us to systems and evaluations that have very little to do with areas where we have some authority, or with what we might actually be accomplishing.

I try to be cautious and take the position espoused by Mark St. John in his 1996 ASTC report, An Invisible Infrastructure, that our institutions are part of the infrastructure that supports lifelong learning, rather than claiming that we provide a specific function within the formal education curriculum. Like libraries, museums are treasuries—in our case, treasuries of phenomena and resources (exhibits, words, people, environments) about science.

I think we should also make a case that we provide alternative learning modalities, valued for precisely the reason that we are not school. If the formal system finds us useful, so much the better. But I hope that’s not the primary reason we exist.

We do have a responsibility to our funders to be accountable, but on terms that make sense for what we are actually about. We also have a responsibility to be accountable to ourselves, because scientists have a habit of mind that constantly insists on testing assumptions and beliefs, no matter how cherished. That includes the beliefs I am expressing here.

I am optimistic that science centers can develop—and, to some extent, already have developed—tools for learning what it is we do, and how we can do it better. Those measures do not always have much to do with the No Child Left Behind vision of accountability. We don’t try to judge a library by measuring what people know pre- and post-visit on statewide standardized tests. That is one measure science centers could use, but only one. We can also measure fun, attitudes, and infrastructure functions.

Of course, science centers, like every other endeavor in our culture, are always going to do some things just because our intuition says we should. But we practice science by measuring what we can measure and by learning how to measure more.

To that end, museum researchers are currently doing ingenious work toward what the Franklin Institute’s Minda Borun, in a pioneering 1977 paper for ASTC, called “Measuring the Immeasurable.” That’s why I am spending a lot of my time with the Visitor Studies Association. I see VSA as a key part of a strategy to become appropriately accountable and sustainable. I urge all of my colleagues to join this work.
**Calendar**

**NOVEMBER**

3–5  **Museum Computer Network Conference.** “Preserving Knowledge into the Future.” Boston, Massachusetts.  
*Details*: www.mcnc.edu/

7  **Math Momentum Workshop: Data and Measurement.** Hosted by the Science Museum of Minnesota, St. Paul.  
*Details*: Maija Sedzielarz, maija@smm.org, 651/221-4554

*Details*: www.hands-on-europe.net

10–11  **ASTC RAP Session.* “A Different Angle: Mathematics Exhibits in the Science Center.”** Hosted by the Museum of Life and Science, Durham, North Carolina.

16–18  **8th Annual SAASTEC Conference.** Hosted by the MTN Sciencentre, Cape Town, South Africa.  
*Details*: mike.bruton@MTNsciencentre.org.za

**DECEMBER**

1  **“Beyond Einstein.”** 12-hour worldwide webcast.  
*Details*: www.wyp2005.org/

2–3  **ASTC RAP Session.* “Innovative Techniques for Training Floor Interpreters.”** Hosted by the New York Hall of Science, Queens, New York.

9–12  **“Science Shows on Physics.”** Workshop organized by the National Council of Science Museums, Kolkata and Mumbai. India.  
*Details*: www.ncsm.org.in

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*Information on ASTC RAP sessions is available at www.astc.org/profdev/. For updated listings, see www.astc.org.*

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**‘Edgies’ Debut at ASTC 2005**

Five ASTC member institutions and two science center professionals received inaugural-year Roy L. Shafer Leading Edge Awards at the 2005 ASTC Annual Conference in Richmond, Virginia. Jury chair Dennis Schatz, vice president of the Pacific Science Center, Seattle, Washington, led the proceedings at the October 16 ASTC banquet.

The awards, newly named in honor of the late museum consultant and former ASTC president (see “Core Values,” page 20), recognize both large and small ASTC members and/or their employees for extraordinary accomplishments in Visitor Experience, Business Practice, and Leadership in the Field. “Edgie” winners receive a commemorative glass award and a paid registration to the following year’s ASTC Annual Conference.

**Business Practice**

Recipients of the Leading Edge Award for Business Practice were introduced by jury member Alan Nursall, of Science North, Sudbury, Ontario, Canada. The large institution winner was the Children’s Museum of Pittsburgh, for its innovative partnership with the University of Pittsburgh Center for Out-of-School Environments. The museum works with UPCLOSE as it tests programs, prototypes exhibits, and performs evaluations, and UPCLOSE graduate students conduct learning research on-site, using the museum’s programs and exhibits as a laboratory.

The small institution award for Business Practice went to Sciencenter, Ithaca, New York, for its *Wall of Inspiration*, a permanent display in the museum’s community room that honors financial supporters (and inspires new ones) while serving as an educational exhibit. Contributors pick a scientist or mathematician whose life and work they admire, and Sciencenter staff create a color plaque—complete with a portrait of the scientist, a description of his or her achievements, and a donor-crafted dedication—and add it to the display. As a fund-raising tool, the *Wall of Inspiration* has far exceeded expectations.

**Visitor Experience**

Dennis Schatz introduced the winners of the awards for Visitor Experience. Faced with two strong entries in the large museum category, one for an exhibition and one for programming, the jury decided to honor both. The Denver Museum of Nature & Science, Denver, Colorado, won for *Space Odyssey*, a 13,000-square-foot permanent exhibition area that integrates immersive environments, hands-on exhibits, live programming, and digital media to deliver timely space science information. *Space Odyssey* was honored as well for its outstanding volunteer corps, the 300-strong Museum Galaxy Guides.

The *Taylor Community Science Resource Center* at the St. Louis Science Center, St. Louis, Missouri, received its “Edgie” for modeling inclusive and thoughtful visitor experiences in science, technology, engineering, and math, and for inspiring other informal education centers. The jury praised the Resource Center’s leadership in public outreach and its commitment to increasing participation of members from historically underserved and underrepresented communities.

The Visitor Experience award for small institutions went to Nebraska’s Omaha Children’s Museum (OCM). In May 2004, OCM became the first children’s museum to host *Titanic: The Artifact Exhibition*, an internationally known exhibition primarily geared to older children and adults. To enhance the experience for younger visitors, staff created Discovery Ports—exhibits designed specifically for chil-
Welcome to ASTC

The following new members were approved by ASTC’s Membership Committee in September 2004. Contact information is available in the Members section of the ASTC web site, www.astc.org.

**SCIENCE CENTER AND MUSEUM MEMBERS**

- **The Center for Water Education**, Los Angeles, California. Part of a developing museum complex at Diamond Valley Lake, the center will include 28,000 square feet of exhibit space, classrooms, and conference facilities when it opens in June 2006.


- **The Ocean Institute**, Dana Point, California. Located on 2.4 acres in Dana Point Harbor, the institute operates an ocean-themed science center that provides programs for more than 100,000 students and 50,000 public visitors a year.

- **Pioneer Ridge Science Education Center**, Independence, Missouri. With more than 20 exhibits and a StarLab Planetarium, this hands-on facility in the Independence School District has hosted nearly 58,000 patrons since its 2000 launch.

- **Tamilnadu Science and Technology Centre**, Chennai, India. Comprising the Periyar Science and Technology Centre, an outdoor science park, and the B.M. Birla Planetarium, the center includes galleries on transportation, energy, materials science, life science, urban development, electronics, communication, and information technology.

**SUSTAINING MEMBERS**

- **ClicknPrint Tickets**, Houston, Texas
- **Cornell University**, Ithaca, New York
- **McMillan Group, Inc.**, Westport, Connecticut
- **Virginia Commonwealth University Life Sciences**, Richmond

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**2005 Sourcebook Due in December**

The latest version of a popular resource, the *ASTC Sourcebook of Science Center Statistics & Analysis 2005* is due to be released in December. The new *Sourcebook* includes more than 60 tables and graphs presenting survey data on attendance and membership; employees and volunteers; and facilities and finances at 186 science centers and museums worldwide.

Featured this year are an analysis of attendance patterns and trends based on four years of aggregated attendance data from a subset of U.S. members; a study of blockbusters at the Arizona Science Center; Zip code data from 14 U.S. museums; and a method used by the Liberty Science Center to map regional patterns of services.

The 2005 *Sourcebook* was compiled by ASTC staff, with contributions by Sheila Grinell, Charlie Trautmann, and Emlyn Koster. The cost of the publication is $40 for members; $50 for nonmembers.

Now out of print, the 2004 *ASTC Sourcebook of Science Center Statistics* is still available in pdf format for $30 members; $45 nonmembers. To order either publication, call 202/783-7200 x140, or write to pubs@astc.org.
Interactive exhibits are also part of the plan. In the Kaneshiro unit, Fly Karaoke invites visitors to listen to and see sonograms of Hawaiian Drosophila courtship calls and then try to match the patterns with their own calls. In Where’s Paabo?, part of the unit on human origins, a giant wall shows 2,700 base pairs of human and chimpanzee DNA; visitors search to find the few places where the two genomes differ.

Exhibitions are now open in Nebraska and at the University of Kansas Natural History Museum, Lawrence, Kansas; the Sam Noble Oklahoma Museum of Natural History, Norman, Oklahoma; and and the Science Museum of Minnesota, St. Paul. Due to open in 2006 are installations at the Exhibit Museum of Natural History, Ann Arbor, Michigan, and the Texas Memorial Museum, Austin, Texas. Funding for the project, which also includes an extensive web site (www.explore-evolution.unl.edu) and a book, Virus and the Whale: Exploring Evolution in Creatures Great and Small (National Science Teachers Association, 2005), was provided by a $2.8 million grant from the National Science Foundation.

Details: Judy Diamond, curator, University of Nebraska State Museum, jdiamond1@unl.edu

ALL TOGETHER NOW—Leaderless synchronization is the concept behind Playing by the Rules: Fish, Fads, and Fireflies at the Museum of Science, Boston, Massachusetts. The new permanent exhibition invites visitors to examine the surprisingly complex patterns that emerge when individuals, from flickering fireflies to sports fans in a stadium interact without a leader.

An entry video shows birds flocking, frogs croaking in unison, and spectators doing the Wave—all examples of decentralized behavior. Visitors are then challenged to create a complex system of their own, synchronizing their actions (in this case, flashing a light) with those of other visitors. In another area, group behaviors throughout history form the basis for “Was It a Fad?” where visitors can flip labels (or test companions’ memories) to discover if pet rocks, swallowing goldfish, and hula-hoops were true fads or just flops.

The centerpiece of the 1,500-square-foot exhibition is the newly renovated Virtual Fish Tank, a simulated undersea world populated by animated fish that first opened in 1999. Smaller user-station monitors have replaced the original large projection screen, making changes in fish tank behavior easier to observe. Visitors can create their own fish, change their attributes, and observe how simple choices made for one individual affect the behavior of a group. Renovations to improve accessibility include wider pathways, audio cues, and button-based commands to complement touchscreens.

Funding for the $500,000 exhibition was provided by exhibit endowment funds, private donations, and a National Science Foundation grant.

Details: Julianne LaMay, publicist, jlamay@mos.org

‘WORLD’ SERIES FINAL—Natural history and natural resources are the focus of The World Around Us, the final addition to the “World” series of permanent exhibitions at the Louisville Science Center, joining The World Within Us and The World We Create.

Opened in September at the Kentucky museum, the new 8,000-square-foot exhibition combines artifact displays with more than 40 hands-on activities to demonstrate that all beings, especially humans, leave ecological footprints in the natural world.

The exhibition is presented in three sections, each with a cluster of exhibits:

• In Atmosphere: Air That Surrounds...
A multimedia station helps visitors learn how a change in the animal population can affect the biodiversity of an ecosystem. Photo courtesy Louisville Science Center

Central to the expansion project is Lookout Cove, a 2.5-acre outdoor exhibition featuring natural, cultural, and built icons of the Bay Area. Visitors can explore a rocky cove, sea cave, and tidal pools; dig up clues from a shipwreck; or help construct a model of the Golden Gate Bridge. Artistic interpretations blend with science content in interactive artworks like Birds of Prey and Mechanical Fish.

Indoors, the museum’s Wave Workshop recreates the habitat under the Golden Gate and teaches visitors how organisms adapt to such environments. Here, children can handle live animals and preserved specimens, or try on costumes and transform themselves into bay animals. Young engineers may also use special racing tables and equipment to test fish and boat shapes for speed and streamlining.

Other additions and enhancements include a 180-seat multipurpose performing arts theater, a media clubhouse for technology-based art and science programs, indoor and outdoor Tot Spots for preschoolers, and a renovated art studio.

Funding for the $19 million expansion came from the Marin Community Foundation, the Kresge Foundation, NSF, the Richard & Rhoda Goldman Fund, the Koret Foundation, and individual family donors.

Details: Mel Ochoa, publicist, mochoa@badm.org

OUTDOOR FUN—Art and science go hand in hand at the newly expanded Bay Area Discovery Museum, in Sausalito, California. The museum completed its three-year renovation in August with the opening of My Place by the Bay, an exhibit area that invites visitors to play as they learn more about their region and its environment.

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Details: Mel Ochoa, publicist, mochoa@badm.org

Grants & Awards

Twenty-six U.S. ASTC members received grants totaling $1.25 million in July from the Partnership for Lifelong Learning program of the MetLife Foundation. The purpose of the program is to increase science education opportunities for people of all ages and to encourage exhibitions that promote a better understanding of aging.

Among the funded programs are Life: The Science of Aging, an addition to the Hall of Life at the Denver Museum of Nature & Science; a multimedia project, Wisdom of the Ages: Lessons Learned at Our Elders’ Knees, led by the Brogan Museum of Art and Science in partnership with several Florida agencies and educational institutions; and the Discovery Learning Series, 6- to 8-week-long courses, seminars, and lectures on public access cable television coordinated by the Discovery Museum and Planetarium with other Bridgeport, Connecticut organizations.

For a list of all grantees and details on the Partnership for Lifelong Learning program, go to www.metlife.org.

The Museum of Science, Boston, in partnership with the Science Museum of Minnesota and the Exploratorium, has been selected by the National Science Foundation to lead a five-year $20 million effort to form a national Nanoscale Informal Science Education (NISE) Network of multiple science museums and research institutions.

Leading educators and researchers, as well as ASTC, will collaborate in the project, which will develop and distribute innovative approaches to engaging Americans in nanoscale science and engineering education, research, and technology. The award is the largest ever given by NSF to the science museum community. The first two years will focus on developing the network and researching the best ways to engage public audiences. The second phase will be devoted to the production, implementation, and dissemination of educational and professional development activities and materials.

For more details, visit www.nsf.gov.
Core Values: The Legacy of Roy L. Shafer

Former ASTC president and longtime ASTC advisor Roy L. Shafer died suddenly on July 29, 2005. He was 54.

Roy’s science center career began in the 1960s, when he first volunteered at the Center of Science and Industry (COSI) in Columbus, Ohio. He soon became an important figure at the museum, founding its camp-in program and later serving as COSI’s president and CEO for 13 years.

Roy was a member of the ASTC Board of Directors for 11 years (1985–1995), including two years as president. After he started his own consulting firm, the Roy L. Shafer Company, he became ASTC’s organizational coach, helping the association to develop its mission, strategic plan, and core values and objectives. In 1999, he received the ASTC Fellow Award for Outstanding Contribution. In presenting the fellowship, ASTC president Jeff Rudolph said of him: “Roy’s unwavering sense of mission for our field is infused with progressive thinking and dynamic leadership, and is always enriched with humor and caring for his colleagues.”

Following his death, many of Roy’s friends and colleagues offered testimonials to his impact on the field.

“Roy had such a clear vision and commitment.... He supported me wholeheartedly when I brought up the idea of a Science Centre World Congress—without his ‘go’ we would never have gotten there,” recalled ASTC president Pelle Persson, whose institution, Heureka, the Finnish Science Centre, hosted the first SCWC in 1999. “We have lost a great leader, but his memory will prevail.”

“In the early 1990s, I was often asked to name the ‘best’ museums. I always included COSI because Roy created a consistent vision of what COSI represented—visitor services,” wrote another ASTC Fellow, Tom Krakauer, former director of the Museum of Life and Science, Durham, North Carolina.

“I cannot imagine an ASTC conference, an ASTC Board meeting, or a Science Centre World Congress without Roy,” added Lesley Lewis, an ASTC board member and Director General and CEO of the Ontario Science Centre. “I will always remember his zest for ideas, his insights, his desire to make a difference (and he did), his warmth, and his amazing ability to stay engaged with friends and colleagues, even at a distance.... Roy’s is truly a life to celebrate.”

All of us at ASTC extend our deepest sympathies to Roy’s family, as well as our promise that we will continue to uphold the core values—strength in collaboration, joy in experiential learning, and superior service to members—that he so skillfully helped us to articulate. —Bonnie VanDorn and Wendy Pollock.