INFORMAL LEARNING

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PACIFIC SCIENCE CENTER TURNS 50: THE HISTORY, EVOLUTION AND IMPACT OF THE NATION'S FIRST HANDS-ON SCIENCE CENTER

David Haldeman and Crystal Clarity

Introduction

On October 22, 2012, Seattle's Pacific Science Center celebrated its 50th anniversary and the informal learning field celebrated a milestone in the history of the modern science center. What began as the highly popular US Science Pavilion at the 1962 Seattle World's Fair gave birth to the nation's first museum founded as a science and technology center, housing not collections and artifacts, but instead expansive halls filled with hands-on exhibits, interactive demonstrations, and staff and volunteers trained in inquiry-based learning methods. The Science Center's early leaders had the foresight to recognize the incredible potential and unique and essential role that non-collections based centers could play in fostering lifelong interest in science and technology. Seattle journalist and World's Fair historian Knute "Skip" Berger recently wrote in Crosscut.com about Seattle's love of science and Pacific Science Center's part in weaving science into the region's cultural fabric.

"The [1962 Seattle World's] fair's legacy would have been huge even if the Science Center was

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SCIENCE SHOWS: PAST, PRESENT AND FUTURE

Graham J. Walker

Science demonstrations have been around for a very long time indeed, and their popularity and ability to engage the public mean they will be, well into the future. Perhaps it began with a prehuman ape demonstrating the technique for 'fishing' ants from a nest with a stick—a demonstration still popular with chimps today. Most people, however, credit Britain's Royal Institution (RI) for bringingpublic science demonstrations to the fore. These lecture-demonstration 'shows', designed for the lay-public as opposed to scientific peers, have evolved into today's science shows.

The RI's efforts were built on those of The Royal Society in London in the late 17th century, where John Keill gave public lectures on Newtonian mechanics (Taylor 1988)–a subject still popular in shows today. It was, however, the efforts during the 19th century of Humphry Davy and his successor at the RI, Michael Faraday, which are usually credited with planting the seeds of modern lecture-demonstrations and science shows.

Davy's "shows" became popular with the public, including high society and royalty (James 2002), and embodied many elements still critical in 21st century science shows, including interaction with the audience. Selecting a volunteer to inhale nitrous oxide is not likely to feature in today's shows—"There was Respiration, Nitrous Oxide, and unbounded Applause. Amen!" wrote Davy on his early lectures (quoted in Holmes, 2008, p. 287)—though may get a laugh if it were.

Davy had a major impact on science, discovering many new elements and inventing devices like the miner's headlamp, but he also shared that science with the public and other scientific disciplines—albeit with mixed results. According to the Chemical Heritage Foundation (2010), "His recommendation that nitrous oxide (laughing gas) be employed as an anaesthetic in minor surgical operations was ignored, but breathing it became the highlight of contemporary social gatherings."

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the only surviving pavilion — bigger than many a fair's contribution to civic life. The Science Center stands today as a secular temple to the truth and its pursuit; it teaches and engages our children, it wows us with exhibits from robotic dinosaurs to King Tut and even brings us Laser Floyd." (Crosscut.com, Seattle's Great Science Renaissance, September 27, 2012)

The Beginnings

After the launch of the Sputnik satellite by the Soviet Union in 1957, the United States faced a choice: redouble its efforts in science and technology or risk losing the Space Race. This new sense of urgency drove the United States to look for bolder, grander, and larger-scale ways to inspire the public in science. They found one in a World's Fair being planned in Seattle.

Originally conceived in the mid-1950s as a "Festival of the West," Sputnik prompted the World's Fair to instead adopt science, aerospace and "the future" as the major themes of the exposition. In hearings about the fair, civic leaders stated that America's "very survival during the next century depends upon how well we develop our scientific resources." It was decided that one of the cornerstones of the fair would be the United States Science Pavilion, a federally-sponsored exhibit to inspire and encourage young people to take up careers in science. In appropriately futuristic fashion, a radio impulse was transmitted from the nation's capital in Washington, D.C., bounced off the moon, and then received in Seattle as the signal to break ground on the Pavilion on February 21, 1961.

Designed by Seattle-born architect Minoru Yamasaki, the United States Science Pavilion was a massive success. Its architecture alone prompted nearly universal praise at the time: the art critic for the New York Times wrote, "The hit of the Seattle World's Fair is the United States Science Pavilion, a dreamlike building before which people stand murmuring, 'beautiful.'" Journalist Alistair Cooke was even more enthralled: "As you come closer and are surrounded by the concrete surfaces everywhere, and the delicate and rippling interplay of light and water, arches and scintillating stone, it is as if the Gothic style had passed without a break [through the ages]. It is as if Venice had just been rebuilt." Yamasaki, along with the Pavilion's iconic arches and foundations, even made the cover of Time magazine in 1963.

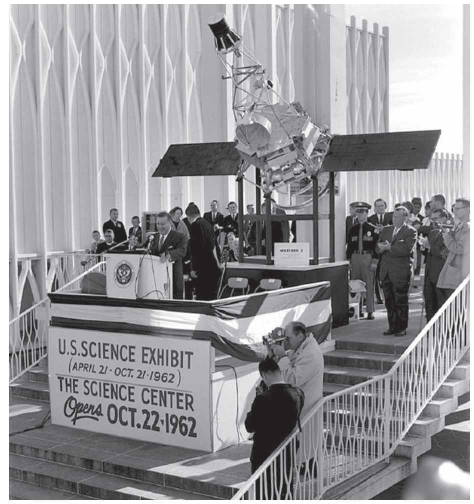
The inside was just as intriguing. It was the first time a single exhibit of that size and scale had been devoted solely to science communication, and particularly, communication of "the connotations, the textures, and the innate joy of science, rather than its massive technology and often staggeringly complex findings." Its theme did not dwell on one particular scientific discipline nor set of facts; instead it presented a storyline of humankind's attempts to understand the universe, with the intention of sparking a better understanding and appreciation of science as a whole. A visitor's experience began in what is now the PACCAR IMAX® Theater with a film by the legendary Charles and Ray Eames entitled "The House of Science." The remaining buildings were then visited sequentially, giving visitors a storyline of scientific progress and possibility throughout history, with exhibits titled "The History of Science," "The Spacearium" (now the Laser Dome), "The Methods of Science," and "The Horizons of Science." In total, 6,748,000 people visited the U.S. Science Pavilion from April 21st to October 21st, 1962.

As the fair progressed however, there was the question of what would happen to the buildings *after* the fair was over. The U.S. Government had a vision for Yamasaki's quiet ponds, sweeping arches, gothic walkways and floral fountains: a storage facility. Seattle's civic leaders however, had another idea:

> *"It should enrich the life of the community. It should amuse, beguile, stimulate, inspire and inform. It should complement and supplement the interests and scientific resources of this area. […]The Pacific Science Center should pioneer in a great experiment designed to show that the essence, aims and methods of science can be widely appreciated in the general population."*

–Dixy Lee Ray, Pacific Science Center's first Education Coordinator and Director (1963-1972)

The government recognized the potential of such an institution, and agreed to lease the buildings to the newly-formed committee for $1 per year, and the name Pacific Science Center was chosen—the first institution in the world to call itself a "science center." On October 22, 1962, the day after the Fair's closing, the United States Science Pavilion reopened as Pacific Science Center.



Historic Photo from Seattle Post-Intelligencer

In the early years, however, Dr. Ray's "great experiment" struggled. Financial support proved highly challenging for the fledgling institution, as much of the business and education community were largely unaware of the need for the kind of supplementary science education offered by Pacific Science Center. The institution's first few years saw continually mounting debt, although state, county, and city assistance along with grants from the National Science Foundation, the Seattle Foundation and others helped keep the organization alive. Gradually momentum began to build, and many of the financial elements familiar today took root. Admission, which was initially free, was charged (at $1 per person), a membership program was put in place, and a store was opened. The first Festival of the Fountains was held in 1963, and a "Science Circus" was held in December during school breaks, adding an additional incentive for families to visit. New exhibits and programs were added and expanded, lectures and events were held, facilities were upgraded, and Pacific Science Center's reputation—and attendance—grew.

After laying the philosophical and programmatic foundations for Pacific Science Center, Dr. Ray's tenure ended in 1972 when she was appointed by President Nixon to head the U.S. Atomic Energy Commission (she would later become the first female governor of Washington State). Two years later, Pacific Science Center would pioneer in another experiment: During the energy crisis in the 1970s, many school groups were unable to afford the cost of visiting Pacific Science Center, so in 1974 the Science Center was brought to them. A program was created to bring hands-on exhibits to school classrooms, and would become the first science outreach program of its kind in the country. What would later grow into a fleet of vans reaching 150,000 students each year began with a handful of Science Center staff transporting portable exhibits in their cars to local schools.

Science on Wheels from Pacific Science Center

That same year, another significant milestone occurred. At this time, Pacific Science Center was the only non-federal agency to be occupying federal land—a situation that made alterations and renovations challenging, often made potential funders wary, and provoked general uneasiness since the federal government could revoke the lease at any time and for any reason. That changed in 1974 when the Pacific Science Center Foundation received the title to the buildings and grounds on the condition that it must remain a science museum for the next 30 years. With greater control over its future attained, Pacific Science Center began more infrastructure improvements. Building 4 was renovated from an astronomy- and space-travel-themed area to become a traveling exhibit hall, the planetarium was completed, laser capabilities were installed in the Spacearium, and in 1979 the Eames Theater was remodeled to become the Eames IMAX Theater.

In 1980, the tenure of George Moynihan as Executive Director began, which was to last more than two decades. Pacific Science Center saw its reputation grow internationally in 1984 with the exhibit *China: 7,000 Years of Discovery*, which featured Chinese scientific and technological innovations. The exhibit drew the biggest sixth-month attendance in Science Center history until that time, and helped solidify Pacific Science Center's reputation as an important Seattle cultural institution. At its end, it had become the second largest attended exhibit in Seattle history.

Moynihan also oversaw sweeping changes and additions to Pacific Science Center in the 1990s through a $40 million capital campaign, which saw the construction of architectural elements and additions that are familiar today: the Ackerley Family Exhibit Gallery, the 3D-capable Boeing IMAX Theater, the Tropical Butterfly House, the Kiewit Pavilion, the Seattle Rotary Discovery Labs and the James Albert Claypool Memorial Garage. Other programs also began to expand, including summer and school break camps and camp-ins.

In 1993, Pacific Science Center's programming expanded eastward. The Science Center and the City of Bellevue recognized the need to not only tell children about the fragility of the natural world, but allow them to see its fragility for themselves. On a hill overlooking 320 acres of pristine marshes, rivers, woods and meadows, the Mercer Slough Environmental Education Center (MSEEC) was created with the purpose of allowing urban children to explore the natural

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environment through the Slough's network of trails and streams, and then return to the MSEEC to understand the science behind what they'd seen. The MSEEC is a collaboration between the City of Bellevue, which owns and maintains the land and buildings, and Pacific Science Center, which creates and runs the programming. The MSEEC hosts field trips, sleepovers, camps, expeditions, parties, public outreach programs and teen internships all with a common purpose: to encourage wonder and curiosity about the environment. Originally based out of a single historic house, in 2008 the facility was expanded into a state-of-the-art, LEED Gold-certified facility including classrooms, a wet lab, a specimen lab and even a tree house.

Mercer Slough Overlook from Pacific Science Center."

Soon after the completion of Pacific Science Center's massive push to expand its infrastructure and offerings, George Moynihan retired. Bryce Seidl became President & CEO in 2003, and with his appointment came the revival of an underemphasized aspect of Dr. Ray's original vision for Pacific Science Center: collaboration with universities and research institutions. Under Seidl, greater partnership efforts began when in 2005, Vice President of Education Dennis Schatz began meeting with the Polar Science Center at the University of Washington to bring their scientists to meet with our visitors to demonstrate their research. This led, along with a grant from the National Science Foundation, to the launch of Portal to the Public in 2007, Pacific Science Center's initiative to bring current science and scientists to our visitors. Portal to the Public began as a handful of large-scale yearly events in which scientists from universities and laboratories engaged with visitors using hands-on exhibits based on their research. The program has since grown immensely, and now includes monthly Scientist Spotlights, a permanent exhibit space for local research called the Portal to Current Research, and Science Cafes in Seattle, Kirkland and Tacoma. The program became not only a regional but national success, and was awarded the Roy L. Shafer Leading Edge Award in 2011 by the Association of Science-Technology museums—the highest award bestowed by the international science museum field.

Polar Science Weekend from Pacific Science Center

The 2000s also saw Pacific Science Center host a succession of prominent exhibits, including *Titanic: The Artifact Exhibition* in 2001, *Discovering the Dead Sea Scrolls* in 2007 (which would become the second highest attended exhibit in Science Center history) and *Lucy's Legacy: The Hidden Treasures of Ethiopia* in 2008. The decade also saw the adoption of a new Strategic Plan, and Pacific Science Center's current mission statement: *to inspire a life-long interest in science, mathematics and technology by engaging diverse communities through interactive and innovative exhibits and programs.*

In preparation for its 50th anniversary in 2012, Pacific Science Center applied for Historic Landmark Designation from the City of Seattle. In recognition of the importance of our institution's architecture and cultural impact, the Landmarks Advisory Board unanimously designated our campus as a Seattle historic landmark under all six designation criteria—the only building aside from the Space Needle to be nominated under all six.

PSC campus exterior from Pacific Science Center

With over a million visitors and program participants each year in Seattle and around the state, Dr. Ray's "great experiment" is a great success. In the next few years following this great experiment, a few other important pioneers opened hands-on interactive institutions—notably COSI Columbus and the Ontario Science Center in Toronto. The opening of the legendary Exploratorium in San Francisco by Frank Oppenheimer in 1969 cemented the foundation for a whole new field. As the power of this form of engagement in science learning was recognized, long established museums around the world began adopting interactive methods of engaging audiences. Other communities began building science centers, a phenomenon that is vigorous on a global scale from Africa to South America to China and beyond.

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"Shows," continued from front cover

Before retiring, Davy appointed his "greatest discovery" Michael Faraday to the RI. He was the next major pioneer of the science show and the most instrumental figure in the early development of the genre. Significantly, he was the first to seriously reflect upon the nature of demonstration-lectures themselves. Faraday, whose scientific legacy is immense and included discoveries such as magnetic fields and electrolysis, is a fine example of someone whose interest in science was sparked by (in today's terms) science shows. Faraday is evidence that these short encounters can spark and further encourage interestand motivate future careers. His beginnings are described by James (2002) in a historical account of the RI's lectures.

"Towards the end of his apprenticeship a customer at the bookshop [where Faraday worked] saw Faraday's lecture notes and gave him tickets to attend the last four lectures to be delivered by Davy in the Royal Institution's theatre. Faraday took detailed notes of the lectures and sent them to Davy asking for a job in science. After a complex set of events Faraday was appointed to the Royal Institution in March 1813. Thus Faraday owed the beginning of his career in science to the lecture theatre, and it seems unlikely that he forgot this debt." (p. 226)

Perhaps this debt is why Faraday was such an exemplary performer and invested himself greatly in creating better lecture-demonstrations. Faraday was the earliest science show theorist and spent time analyzing what made a good lecture, including setting, audience, delivery, the presenter, lecture content, and the importance of demonstrations (ibid.). He is even cited as resolving to never again present a lecture sans demonstrations after delivering a standard lecture in 1854; indeed, it was an area he felt strongly about.

"[Faraday] never merely *told* his hearers about an experiment," wrote Thompson (2005) in a recent biograhpy, "but *showed* it to them, however simple and well known it might be." To a young lecturer he once remarked: 'If I said to my audience, "This stone will fall to the ground if I open my hand," I should open my hand and let it fall. Take nothing for granted as known; inform the eye at the same time as you address the ear." (p. 232)

Live demonstrations—seeing, hearing, smelling, feeling or otherwise experiencing scientific phenomena—is what defines a science show and its roots as a "lecture-demonstration" (a term still used to describe shows in academic circles). Demos, as aficionados fondly call them, differentiate shows from related genres such as museum theatre, which tends to make greater use of characters, narrative and dramatic techniques (Bridal 2004). There is something inimitably inspirational about a live demo, a point made by Lawrence Bragg(Faraday & Bragg, 1974), another of the RI's science show pioneers.

"It is surprising how often people in all walks of life own that their interest in science was first aroused by attending one of these courses [science shows] when they were young, and in recalling their impressions they almost invariably say not 'we were told' but 'we were shown' this or that."(Illustrations and experiments section, para. 5)

Recently, the RI have digitized some classic science shows performed in its legendary theatre, including Bragg's *The Nature of Things* from the late fifties and the wonderfully demo-rich *Famous Experiments*, by ex-director George Porter (see http://www.richannel.org). Porter's lecture traces the history of the RI through a series of amazing demos, including a favorite of Faraday where he electrolyzes water into hydrogen and oxygen, captures it in bubbles, and ignites it in his palm with a loud bang. It is interesting to note that today's science shows, typically, use a far less exciting version of this demo, with flammable gas from a cylinder and no added oxygen. Faraday was, and still is, ahead of his time.

Contemporary science shows owe much to Davy, Faraday, Bragg and many others and their combined wisdom is well worth digging up. Faraday and Bragg's *Advice to Lecturers*1974; an anthology of insights) should be required reading for any contemporary science showoff. In a way, Faraday's shows live on through his establishment of the RI's Friday Evening Discourses and Christmas Lectures for children and families, which continue to this day and are replicated across the world.

Modern show performers share Faraday's goal "to make science a polite entertainment requiring the sort of suspension of disbelief that is associated with the theatre"(James, 2002, p. 227). Moreover, for the most part, they share the goal of the RI which "has been and remains to inspire audiences, not necessarily to educate them" (ibid., p. 227).

The average 21st century science show is not so different from those presented by Faraday; it is interactive, demonstration-based, favors inspiring over educating, requires consideration of and relevance to the audience, hinges on presentation as well as content, and typically deals with physics and chemistry. Presenters may be scientists or actors (a debate not entered into here), but all use dramatic tools and public speaking techniques. Beyond simply communicating science, the aim of most science shows is to foster positive attitudes about science, spark interest, inspire curiosity, and generally promote further study and careers in science. Hence, most science shows performed today are about inspiration in a broad and subtle sense.

A rarer form of science show aims for targeted inspiration: to motivate specific behavior, often relating to a societal issue. It employs all the tools noted above to deliver a focused science-based message to influence the audience's attitudes, motivation, and behavior in particular ways. Although examples are scarce, these shows usually focus on motivating action relating to the environment, such as recycling (Our Planet Enterprises 2008), or on health, such as reducing smoking (Koster and Baumann 2005) or tackling HIV AIDS (Walker,

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Stocklmayer, and Grant 2011). Most shows in this area tend to use more theatrical devices like characters, costumes,special effects, and far fewer demonstrations. How the power of demonstrations can be better harnessed in these motivational-type shows is an exciting question as shows evolve into the future.

I have been fortunate to be able to look at the effects of some of these motivational shows in detail during my PhD research, with exciting results. The bottom line is that science shows are potent motivational tools. This extends not only to inspiring science careers and further study (a common application), but also to tackling serious community problems such as climate change and HIV AIDS. Working with the Unizul Science Centre in South Africa, we found that a science show and short science center program could have significant positive effects on a range of behaviors that put young people at risk of HIV infection(Walker, Stocklmayer, and Grant 2011).

One story of particular note comes from a teenage boy who participated in follow -up interviews a month after seeing the *Alarming AIDS Adventure* science show. When he came to the show, he had three girlfriends—a common thing in Zulu culture, but also a risk factor for HIV infection. A month later he told us he had decided to only have a single partner as a result of the science show experience. Teenage girls told stories of similar impact; how they had refused to have unsafe sex after hearing these messages in the show. Hopefully these effects are widespread and sustained—only determined future research will tell. It is a powerful reminder that science shows can be so much more than laughs, bangs, and pops: they can be tools to make people's lives better, and even save lives.

So what does the future of the science show look like? Certainly, there is great potential for shows to break the standard moldand be more widely used as motivational tools to address socio-scientific issues. The rarity of shows in this area is concerning, given science communication more broadly regularly operates in the overlap of community problems and science. Widespread health problems like HIV AIDS and diabetes, along with environmental issues like climate change, energy use, and recycling are all ripe for science show practitioners to take to the stage and bring to life through demonstrations, yet they rarely are.

While these types of shows are more challenging to create and make engaging for audiences, managers, and practitioners–particularly at the science center level—must question what their obligations to their publics are. If science can provide guidance or different perspectives as to how to deal with these problems, surely we should be communicating this. It is asentiment shared by some seminal museum researchers, such as in Weil's (2002) book *Making Museums Matter*, as noted by Koster and Falk (2007, p. 1):

"Museums [or science centers] should exist not just for the scholar or elite, but for the greater good. The premise that museums should matter in this way is an intensely responsible proposition. To pose the opposite question—why would a museum wish not to benefit society and/or the environment in the greatest possible way?—is to emphasize the choice now being presented to the museum field. Surely, today, the most compelling rationale is that, locally and globally, the myriad of opportunities and challenges faced by society and the environment would greatly benefit from the kind of informed perspective museums could provide."

Addressing these challenges, I feel, is the most critical area to consider as demonstration-based science shows evolve, but there are many other fascinating avenues. Further fusion with theatrical forms is chief among these. Science show performers have long used dramatic tools, but only recently have people begun creating demonstration-based shows that make full use of theatrical techniques and devices. For example, Fusion Science Theatre's use of a "dramatic question" to structure children's chemistry shows (Kerby et al. 2010).

"This device, known by playwrights as the 'dramatic question', sparks curiosity, elicits attention, and motivates the audience to wrestle with the problems presented as the play unfolds. A well-crafted dramatic question provides context and urgency to the many smaller questions that are posed, answered, and linked together to form the plot." (p. 1024)

Science Made Simple's *Visualise*, which I had the pleasure of performing alongside of at the recent Abu Dhabi Science Festival, is another inspirational example. The show uses physical theater, no dialogue, engaging and often beautiful demos, multimedia, theatrical effects, and two accessible characters to create a sense of wonder and curiosity around the science presented.

"I was very influenced by my own interest", explains performer/creator Debbie Syrop, " in how artists have worked with science centers." They create some of the most absorbing and playful interactive exhibits. I noticed that "art" can be extremely successful at raising questions and encouraging reflective thinking. Something that our frothy, instant, whizz-bang shows don't necessary achieve.

"I've spent a lot of time thinking about how science shows could learn from more established theatrical art forms like magic, circus, cabaret, drama, dance etc. I've come to the conclusion that it's about being audience-centric. In science shows we tend to focus on the content and the presenter (only two corners of the golden triangle that magicians tend to talk about). Our thinking about audiences is somewhat basic, usually confined to considering appropriate language and concepts. Rarely do we extend this thinking about motivation, connection, emotion, personalization, and journey. Rarely do we consider the show through the mindset of the audience. We should. The best shows touch the audience."

Visualise is one of the few, possibly only, demo-based theater shows that left me quietly reflective, thoughtful, and inspired about how science permeates our everyday lives and is aesthetically stunning. This relevance and beauty of science was brought to life most profoundly through the demos, made more accessible by performers, and enhanced by the multimedia and theatre effects.

Which brings me to another exciting area for the future of science shows: technology. Presentation tools like Prezi (free online, see www.prezi.com) are allowing presenters to escape the stale, linear offerings of

PowerPoint and also force presenters to pay attention to story, conceptual grouping and visual appeal.Video-conferencing, long used in distance education, is being more widely used. For example Questacon–Australia's National Science and Technology Centre has recently installed a full studio that lets them reach audiences across the expanse of Australia and internationally, while also incorporating cutting -edge science and scientists (another area for the future of the demo-based show) from Antarctica to Earth orbit.

Apps are infiltrating shows and give presenters easy access to "toys" that in the past were too expensive, big, or cumbersome to incorporate. Sound wave analyzers and technology to digitally "project" the inner workings of a human body onto a volunteer are just the start. The key challenge for presenters with these new tools is to use them to enhance the communication of science and achieve the show's aims, rather than just be groovy (and possibly distracting) gadgets.

In conclusion, as science shows evolve it is apt to reflect on the essence of a show: science, being communicated by people, for the benefit of other people. Be it the audience or the presenter, the human factor—especially the live interaction between them—will always be a critical aspect and something that keeps the genre fresh and evolving. The human factor also underscores the importance of applying shows to humanity's current challenges where science plays a role. Finally, this article has only touched on some of the innovative future directions for shows—if you are working on others I would love to hear from you.

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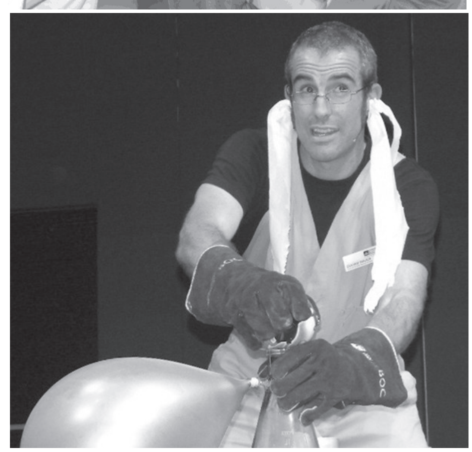

Captions, top to bottom:

Looking at the emissions of natural gas in a show about climate change and the future of energy.

Raising awareness of the contribution made to climate change by methane emissions.

Audience participation in demos and human interactions are a powerful aspect of science shows.

Typical science shows present physics and chemistry in a light-hearted way-here a classic liquid nitrogen demonstration.

Exhibition Review

ELEPHANTS IN DENVER

Robert Mac West

On June 1, 2012 the Denver, Colorado, Zoo opened its Toyota Elephant Passage, a 10-acre, $50 million exhibition with Asian elephants as its focal point. I visited the exhibit in mid-October, with a couple objectives in mind. First, since elephants in zoos are a primary target of the animal-rights/welfare crowd (http://www.peta.org/issues/animals-in-entertainment/get-elephants-out-of-zoos.aspx), I was curious to know how this new exhibition was presenting its collection. Second, with the focus of the exhibit on Asian elephants (http://www.denverzoo.org/toyota_elephant_passage/), I was interested in how the elephants were integrated with other Asian species and also how Asian cultures and environments were integrated into the interpretive program of the exhibition. And third, of course I hoped to encounter some unexpected elements of the presentation.

The exhibit is large, significantly larger than most elephant exhibits in U.S. urban zoos, and may, in fact, be the largest in the country. The 10 acres stretch out over a long space with trails between display/program nodes and the indoor stable/breeding/communal building. This is different from many current elephant displays which feature large open areas (e.g., San Diego, featured in ILR 112).

The exhibit currently houses three animals, a cow and two bulls. The zoo unfortunately lost its elderly female, Mimi, earlier this autumn. There clearly is room for this "herd" to grow. The zoo anticipates adding three males in the next year and, long term, playing a role in the national elephant breeding strategy.

There are lots of opportunities for the elephants to walk actively—a long-standing criticism of zoos—and the keepers make sure that they do move around regularly. There also are large water areas where the elephants can swim and float. Mud wallows, scratching trees, and shade structures all contribute to numerous behavioral enrichment opportunities. All in all, considering its High Plains geographic and altitude location, the exhibition provides the elephants with a varied environment. The Clayton F. Freiheit Elephant House, which contains the nighttime and inclement weather stalls and the communal Koebel Family Elephant Parlor, has natural sand/soil mix substrate that can readily be changed for both variation and cleanliness. Thus, the elephants aren't standing on concrete for hours at night and when it is cold. This facility is outfitted in a way to assist with reproduction programs—it can house up to 8 bulls in individual quarters, with cows housed in a group.

Visitors approaching the exhibit from the east arrive at the McGrath Family Amphitheater (adjacent to the primary exhibit area). The introductory 15-minute show is presented twice daily. It features the female elephant, Dolly, who is about 48 years old and suffers from partial trunk paralysis. The show is actually part of her training program and includes discussion of her individual needs and how zoo staff provides stimulation and various behavioral enrichments that are specific to her.

The main part of the exhibit is very nicely Asian-themed. In fact, as one enters the main exhibit, which is organized in three sections, a statue of Ganesha, the Hindu elephant deity, provides a welcome. The first encounter area is the Village Outpost. It deals with the interface between elephants and residential areas in a rural village—the resultant destruction of homes and crops and potential killing of the elephants.

Next is a more urban area, the Scholzel Family Village. It includes a large open space with dozens of flapping Tibetan/Nepalese prayer flags waving in the wind and an exhibit with oversized, touchable prayer wheels. Opening off this plaza is the entry into the Clayton F. Freiheit Elephant house, named after a long-serving zoo director. It is, logically enough, delightfully elephant-themed.On the other side is the Soi Street Market with indoor exhibits and retail featuring zoo-themed items of Asian origin. There also are unlabeled outdoor displays of everyday items including bicycles, birdhouses, baskets, lamps, and fabrics.

The third area is the Chang Pa Wildlife Preserve, which mimics a wildlife reserve in an Asian country. It is effectively an island with the primary attraction being several gibbons brachiating through the leafless trees.

The theming throughout the exhibit includes architecture, language and place-names, This all creates a very nice visitor environment without overwhelming amounts of graphic interpretation.

Despite my focus on the elephants, the Toyota Elephant Passage does include quite a variety of other species. In addition to the gibbons on the Chang Pang Wildlife Preserve island, there are rhinoceroses, tapirs, fishing cats, otters, leopards, flying foxes, and snakes. They are a less physically prominent part of the exhibit, but small areas focus on them, making the subtle point that the Asian ecosystem is a complex one.

A bit of a conflict with the Asian theme occurs along the northern side of the Elephant Passage. There, the visitor looks away from the elephants (there actually aren't elephants along this route) and sees part of the adjacent Predator Ridge exhibit. It is populated by hoofed mammals from various non-Asia habitats, thus diverting attention away from Asia. It, unfortunately, is not clear from signage or theming that this is not part of the Toyota Elephant Passage, thus somewhat confusing the primary message.

A very important part of Toyota Elephant Passage is its very strong and pervasive message related to environmental sustainability. The entire area, open spaces and all buildings, have been awarded LEED Platinum status. Graphics throughout the exhibit constantly remind guests of the several major initiatives being taken by the Denver Zoo—and not just in this exhibit. There are many references to the effective recycling of some 90% of the animal waste. This biomass conversion process not only significantly reduces the volume of material passed into landfills but also generates significant amounts of power to operate the zoo. Some 1.1 million gallons of water are filtered after use and then passed on to the animal quarters as well as the zoo's irrigation system. And the list of sustainable practices goes on. The Denver Zoo prides itself on its sustainability practices, and highlights them throughout this exhibit.

Another important aspect of the interpretive program is the regular, but not obtrusive, appearance of panels that discuss interesting facts about specific animals' anatomy, function, behavior, and environment. This is an increasingly important part of any interpretive program—answering the actual questions that come into visitors' minds. How does it do that? What does it eat? How does that particular anatomical structure work? Where does it live? And so on. Panels and simple interactives that address these real questions create a much more satisfactory visitor experience.

Finally, it is very clear who sponsors this very expensive exhibit. In addition to their name in the title of the exhibit, Toyota deals are effusively thanked and Toyota vehicles—both modern and wonderfully old—are encountered as one enters from the east end. There also is conspicuous donor recognition via comprehensive wall panelslistings as well as donor panels at the various exhibits and activity centers.

I found the Toyota Elephant Passage to be an excellent addition to the Denver Zoo and one which both lived up to my expectations and showed me some things that I did not expect to encounter. And I find it reassuring, as I visit zoos in many locations, that the interpretive programs are rapidly becoming more visitor-friendly, the animals are being treated much better, and the focus on world-wide environments and sustainability is becoming much more pervasive.

Thanks to Sean Anderson-Vie, Public Relations Specialist; Brad Parks, Director of Public Programs; Marley Stele-Inama, Education Research and Evaluation Manager; and Craig Piper, President/CEO for their assistance and good conversation during and following my visit.

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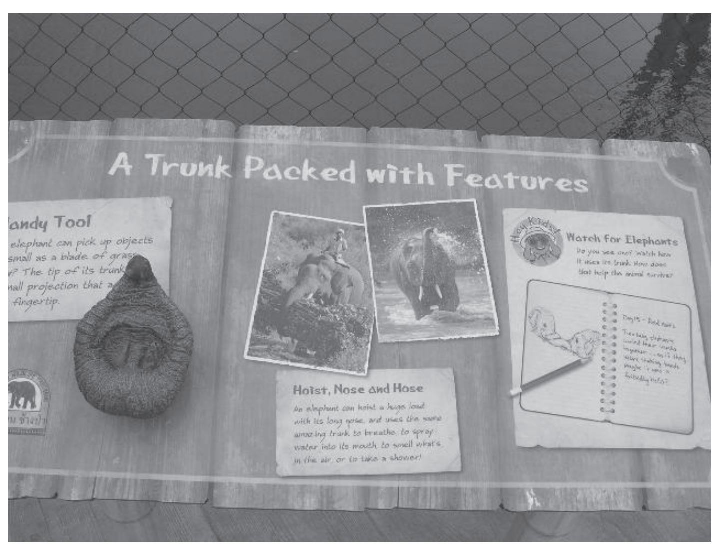
ELEPHANTS IN DENVER

Dolly being sprayed with water at the introductory theater

Elephant ears interactive presentation

Gibbon on Chang Pa Wildlife Preserve



Information panel on the functions of the Elephant trunk

ELEPHANTS IN DENVER

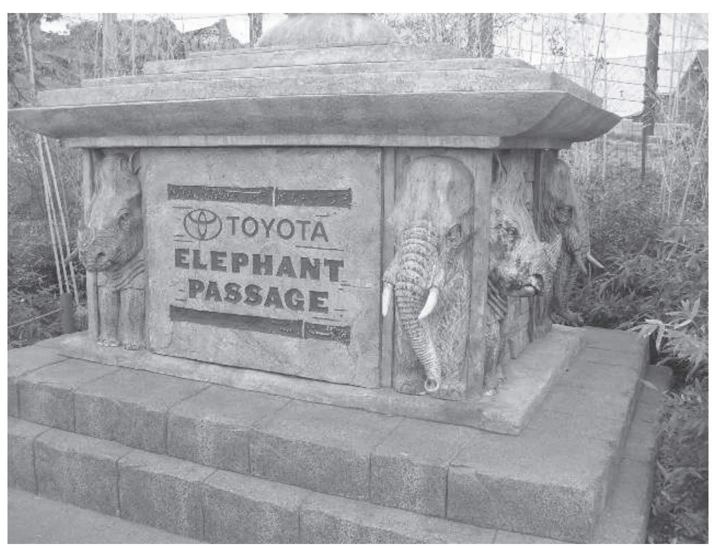
Ganesha

Themed signage

Prayer flags above plaza

Entrance to Clayton F. Freiheit Elephant House

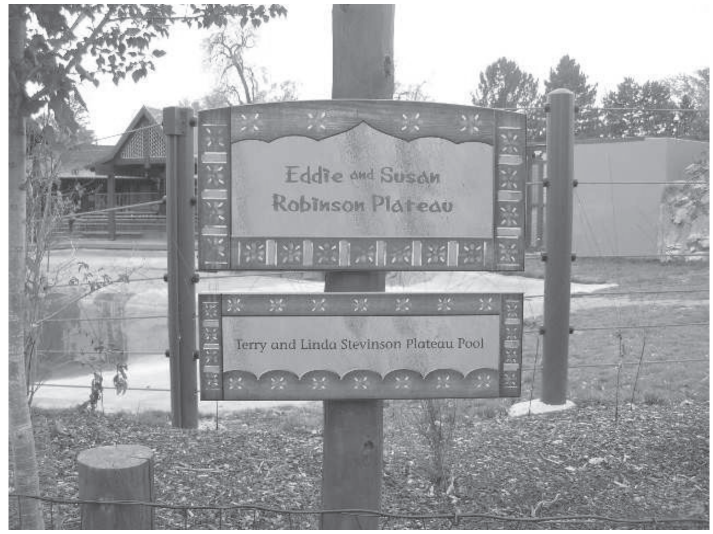
Interactive giant prayer wheels



Entrance

ELEPHANTS IN DENVER

Cultural items display



Donor acknowledgement

HOW MUSEUMS AND MUSEUM EXHIBITS CAN INFLUENCE BEHAVIOR

Jonathan Katz

Some museums today are finding it consistent with their educational missions and role in the community to convey their messages in a way that makes people reflect upon, and even change, their behavior. In treating some topics, such as environmental and social causes, there's a desire to go beyond imparting information, to stimulating action or even activism. Museums are doing this through exhibits designed to help visitors make a visceral, emotional connection to the subject and give them the tools to participate. They are aided by their position of trust in the community, which identifies them with reliable information and authenticity. They may make use of experiential and high-tech environments with social and gaming components to actively bring visitors into the story and speak the language of younger generations and diverse audiences. The message goes home with the visitor, and they in turn can become agents of change through their subsequent actions.

Transcendent Takeaways

The Monterey Bay Aquarium Seafood Watch program bills itself as something that "helps consumers and businesses make choices for healthy oceans." It creates awareness about sustainable fish choices for the dinner table. A visit to the aquarium—or its website—not only reinforces an appreciation of the world's marine life, it shows people what they can do to help preserve it through everyday actions. The data are presented along with actionable suggestions for consumers and for businesses—even including recipes. "The choices we make, one meal at a time, add up," is how the museum summarizes it.

This influential program does extend to actual exhibits such as the Real Cost Cafe, an interactive that in a faux cafe setting taught visitors about sustainable fish orders, but its success has taken the institution's brand far beyond the physical walls of the aquarium, aided by electronic media and a simple takeaway. The Seafood Watch pocket guide/ smartphone app of checklists is tailored to a variety of regions, to keep in one's wallet and consult when at the restaurant or the fish market. The museum reports distributing more than 40 million pocket guides since 1999, plus nearly 1 million downloads of the smartphone app, and that Seafood Watch has some 200 partners across North America, including the two largest food service companies in the U.S. This simple item has had a domino effect: Consumers have changed their buying behavior, causing restaurants and stores in turn to change <u>their</u> buying behavior. In some ways the result has nothing to do, specifically, with aquariums anymore—it's a study in changing behavior—motivation, education, information and finally implementation. It's a circle completed—and evidence of how focused educational objectives can have big effects.

Branding Benefits

The Seafood Watch pocket guide has a life of its own, but its power begins with the authoritative, authentic voice of the institution. Another circle completed—the museum speaks from its position of authenticity, using its power for good, so to speak, and when that voice has a powerful reach, that comes back to further reinforce the standing of the museum—building its brand.

Seafood Watch demonstrates how a museum can speak from its place in the community to influence behavior and by doing so with integrity, positively reinforce its position, its image, and its relevance. People look up to museums as authentic and accurate arbiters of knowledge, and are disposed to accept the message delivered as true and accurate. Properly

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used, it's a powerful thing that shows the museum is walking the walk—actively engaged with the community's issues of today and not just things of the past. In today's fast moving media-rich landscape, that is more important than ever in terms of connecting with the young.

Children as Agents of Change

Discovery Science Center exterior

At Discovery Science Center (DSC) in Santa Ana, Calif. the "Eco Challenge" exhibit, a permanent installation that opened September 2011, came about through the museum working with the local waste treatment authority. Both were completely clear in the conceptual stages about wanting to change consumers' recycling behavior, and targeting the message especially to children, the stated goal being to create a generation of "green superheroes." Observing how corporations market consumer products, particularly in the US, it's clear that children are seen as a very powerful influence on a family's consumer choices. The same marketing psychology that helps sell soda and toys and cigarettes can be employed to sell behavior that is good for our health and that of the planet.

Grocery Store exhibit

There are three hands-on, interactive exhibit areas in Eco Challenge. The Discovery Market simulates a grocery shopping experience, with interactive displays on the carts, and engaging animated characters (the "Eco Crew") on video screens. The Eco Garage environment simulates a typical suburban garage and its contents; visitors learn to identify and properly dispose of household hazardous waste. Race to Recycle uses a competitive format to heighten the experience of properly sorting trash to keep recyclables out of the landfill. All the experiences include opportunities to interact, compete, and have achievements recognized.

Race to Recycle exhibit

In researching the approach for Eco Challenge, DSC looked at how people learn and acquire motivation in interactive gaming environments. Again, corporate buzz provides a clue to something museums can adapt: Some very big money is going toward "gamification" research. A USA Today report from August 2012 explains, "Business spending on what has become known as 'gamification' will increase from an estimated $242 million this year to $2.8 billion in 2016, predicts M2 Research, an Encinitas, Calif.-based technology research firm. And many small businesses, as well as 70% of the top 2,000 global organizations, will use "gamified" applications for marketing, employee performance and training, and health care by 2014, projects technology research firm Gartner.

One of the leading voices on the positives of gaming for human development is Jane McGonigal, who explains in her book "Reality is Broken" that gaming is not just a leisure time distraction, but rather the modern manifestation of a basic human engagement process with huge potential for communication and personal empowerment. In her book, McGonigal explains how gaming promotes a level of enjoyment that harnesses social interaction, individual motivation and impulses to learn and achieve as components of play—which can result in a lasting connection to the content involved in the game.

Eco Challenge effectively harnesses these positives, thereby reinforcing the behavior it teaches. That positive association helps the lesson of the experience to stick, and to influence future choices. Kids who have been to Eco Challenge are speaking up at the family dinner table and in the grocery store – arenas in which children often have a lot of influence—saying "I'm not going to eat this anymore," or "I don't want us to buy packages that can't be recycled anymore." They're learning about their environment and how to participate in it.

In other words, bringing gaming into a situation such as Eco Challenge can provide the visitor with tools for coping with reality—not escaping from it. Gaming elements are used here not just because they are cutting edge electronic interactives but to speak a universal language on a fundamental level.

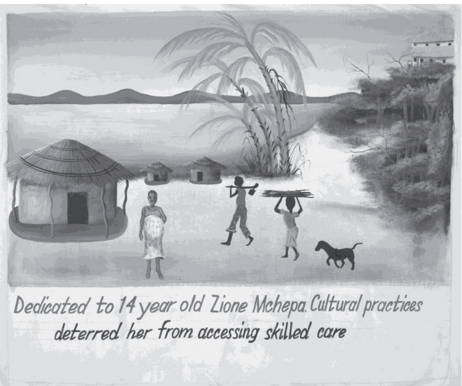
Showing the success of its Eco Challenge education outreach program targeting sixth-graders, DSC released the following statistics: "8,491 sixth grade students taught; 6,088 additional students committed through 8 additional partnerships; 69 teachers educated through professional development workshops; $150,000 additional investment received from Waste Management toward the exhibit." Interactive keypads used at class assemblies to measure students' retention of the key concepts indicated that 83% of respondents were able to correctly classify 8 types of waste (green, hazardous, recyclable, and trash; renewable/non-renewable).

"We are so grateful for the shared vision and leadership demonstrated by the Orange County Board of Supervisors and OC Waste and Recycling," said Joe Adams, Discovery Science Center President. "I am proud that Discovery Science Center is utilizing a first-of-its-kind, state-of-the-art exhibit to educate children and parents on the importance of making eco-friendly decisions for the long-term."

Full disclosure: The author's company produced Eco Challenge for DSC as a design/build project.

Half the Sky

The exhibition "Women Hold up Half the Sky" which completed its run a few months ago at the Skirball Museum, a Jewish cultural center in Los Angeles, was a social call to action. The Skirball partnered with advocacy groups and NGOs to develop it. It was inspired by the critically acclaimed book *Half the Sky: Turning Oppression into Opportunity for Women Worldwide* (Knopf, 2009), by Pulitzer Prize winning journalists Nicholas D. Kristof and Sheryl WuDunn.



Painting from Women Hold up Half the Sky. The exhibit was a call to action, addressing the worldwide oppression of women and girls. Photo courtesy Skirball Museum.

The exhibition was solution-oriented. It addressed the worldwide oppression of women and girls, sharing stories from around the globe of those who changed their lives through education, economics, and self-determination. These were presented through documentary photographs, visual art, sound installations, and interactive gallery experiences, including the opportunity to provide a microloan to a woman entrepreneur.

The tools of empowerment were straightforward. Calls to action came via representatives from NGOs such as American Jewish World Service, CARE, Coalition to Abolish Slavery and Trafficking, International Justice Mission, Jewish World Watch, and Peace Over Violence, speaking at the museum on weekends, discussing actions that visitors could take to make a difference. A computer station with access to www.halftheskymovement.org enabled visitors to learn of many more opportunities and resources. Postcards to Congress regarding pertinent legislation were available to visitors, to be mailed by the Skirball on their behalf.

Skirball Museum director Robert Kirschner said of Half the Sky that it was "not really an art exhibition... not a collection of artifacts. It's about ideas. It's really about social conscience and focusing on certain issues and engaging a broad community."

Stepping Up

The Skirball and the other examples in this article didn't simply offer information, art, specimens, or artifacts—it created a package addressing a critical issue in the world today, and it took a definite stance on that issue. By stepping up and asserting such a position, a museum helps people realize the importance of taking a stand themselves.

The conventional approach is to present the wealth of society's knowledge without the activist message. But we are seeing today that museums are trending toward becoming much more activist—not necessarily in the sense of a political agenda, but in their desire to produce a greater impact from their educational efforts. Becoming much more direct about trying to influence people's attitudes and behaviors is not something every museum wants to do, but it has become much more acceptable. And nowadays, amid a heaving sea of information, misinformation, and manipulation, a strong case can be made that this is what people need from their museums, more than ever. They need to be able to turn to the museum as an authentic, legitimate source of considered information. And because they are museums, people trust them to be ethical. Museums must recognize they have this power, and use it wisely and thoughtfully toward a better world.

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Women Hold up Half the Sky exhibit at Skirball.

TRAVELS WITH AN EXHIBITION

Stephen Pizzey

Traveling hands-on exhibitions can boldly go with missionary zeal, taking science to new frontiers. This was my opening comment for my contribution to the session at the 2012 ECSITE conference in Toulouse entitled "Going the Distance with Travelling Exhibitions". Out of that came the invitation from Robert West to submit this article, which draws on my personal experiences.

We started in 1987 with the Discovery Dome, a traveling science center complete with tent and floor, which toured the UK for seven years. During this time, we designed and built Exploring Science, an exhibition of hands-on exhibits which toured the Middle East and Ethiopia. This exhibition toured for three years, never returning home and became the inaugural exhibition for a science center in Addis Ababa. These were truly adventurous times. Since then, with the expansion and maturing of the science center sector, the scene has become more formal, possibly less adventurous and probably a lot safer for all concerned.

The Discovery Dome in Aberdeen, Scotland 1988.

There is nothing like being on the road, arriving somewhere in the middle of the night with 5,000 sq ft (500 sq m) of tent with fifty hands-on exhibits and nervously anticipating whether your great idea is really so great. Early on in the adventure we arrived in the city of Sheffield and as we were setting up, a group of children appeared, inquiring as to what we were doing. They promptly told us they were

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going to burn it down as we were on their football pitch. So, I showed them around saying they might like to try the exhibits before they set fire to the place. While they were there I asked them to help me move some flooring and generally help out. They agreed it was very good, but they would still be back later to burn it down. The next day they were back and the Discovery Dome was still standing. I got them to move the flooring again and told them that we could not have had a more loyal and enthusiastic band of young helpers.

Everywhere we went we found we could engage local people and recruit them to give demonstrations and assist in running the show. We also found that each location had its own distinct character and people were keen to contribute. At one location an enthusiastic visitor offered to bring his glider and set it up outside. He allowed children to sit in the cockpit and gave lectures about flight to the onlookers. At another location students from the university gave demonstrations and set up experiments for the visitors. Above all, it was the welcoming atmosphere and social activity that was most impressive. The tent, the hands-on exhibits, and the visitors have convinced me that small local science centers with their own distinct character would be a good thing.

I have to admit that the Discovery Dome was not actually a dome. It was comprised of five interlocking geodesic tents, or put more grandly, pavilions, one of which was blacked out for light and color exhibits and another used as a demonstration area. The main area was made up of three modules with the inner walls removed to house the exhibits, the reception desk, and a small shop. There were also some outdoor exhibits, At one venue a sponsor, British Gas, hired some extra tents to show exploration equipment and give demonstrations. As for setting up, the exhibits traveled in one truck and the tent and flooring in another. The size of the trucks was restricted to the size which could be driven on a normal UK driving licence. Also, some of the locations were not accessible to larger vehicles. The exhibits were built in our then small workshop in London. At that time, there was a staff of five including myself— which has since expanded to around thirty. The choice of the tent system was made quite by chance. I needed a system that was simple and quick to erect. One lunchtime I happened to walk by the South Bank in London and noticed a grassed area was covered by hexagonal based geodesic tents. This seemed the ideal solution to the problem of having a 'traveling building' with visual impact and quick assembly. The exhibits themselves were lightweight, simply constructed, and created from ideas from colleagues and some old favorites such as the Bernoulli blower along with some of my own ideas.

The concept worked well, was popular, and triggered related activities. It contributed to the setting up of proto science centers. During the tour, a colleague, George Moynihan, then director of the Pacific Science Center in Seattle, came over to visit the Discovery Dome in Glasgow, Scotland. We discussed the feasibility of a version for the US. Later, George invited me over and work began on Science Carnival, which was based on the same general system of tents and exhibits. I noted some cultural differences during the planning stages. First regarding the budget, George and his team were talented fund raisers and there were no money worries. So, there were no sleepless nights in Seattle although there had been plenty in London. Second, I was getting nowhere trying to arrange overnight security. In the UK we used a security guard with a dog, no problem. As I commented once, those yellowing bloodshot eyes and snarling teeth were quite a deterrent to any intruder and the dog was scary too. In Seattle, security companies were concerned about safety issues related to using dogs. After trying several companies who gave the same story, I was informed that the guard would have a gun. Of course, why didn't I think of that? The tents also got caught up in a mini tornado whereas in the UK we just had gales.

Cultural differences were a feature of our tour with Exploring Science traveling exhibition. The exhibition was originated by ourselves and funded by the British Council, whose charter describes its mission as 'promoting abroad a wider appreciation of British culture by encouraging educational and other interchanges between the United Kingdom and elsewhere', meaning the world. The first venue was intended to be in Kuwait City but Saddam Hussein beat us to it when he invaded Kuwait in the first Gulf war. The British Council arranged for the exhibition to travel to Brussels instead, which provided an opportunity to test the equipment. The exhibition was a small part of a vast festival of science, sport, and various other cultural activities, The exhibition was mobbed. We used folding steel frameworks for the exhibit stands and the exhibits were mounted on steel framed trays which were located on the stands. The frames were packed in one set of flight cases and the exhibits and graphics in another set. Along with the exhibits went rolls of floor matting to define the area and a small version of the optics tent as used in the Discovery Dome for the light and color exhibits. The arrangement was that one of our teams would fly out to assemble the exhibition on arrival at each venue and would train local helpers. My colleague Tim Holdsworth went to Kuwait, soon after the Gulf war ended, where the exhibition was close to destruction as he watched from the taxi as cases tumbled one by one from the moving truck onto the road. A lesser man would have crumbled, as they say, but it was a tribute to Tim who not only suggested using steel in the first place but repaired everything in time for the formal opening attended by Her Royal Highness Princess Anne.

The opening of Exploring Science in Kuwait 1992.

The adventure really had begun.

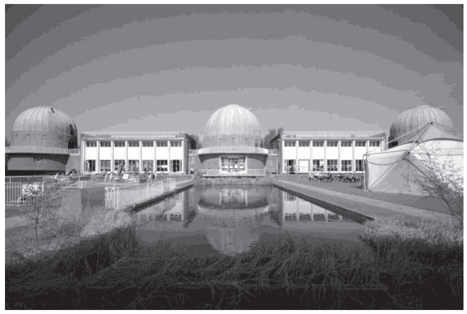
The tour proceeded from Kuwait to locations in Oman, Sharjah (UAE), Jordan, and Ethiopia. The venues were selected by the local British Council offices and associates in the countries concerned. They assisted in every way by providing background and advice and arranging meetings and events. In my own case they also organized visits to schools and other institutions.

Ethiopia was the final destination where the exhibition remained and contributed to the beginnings of a small science center in Addis Ababa. The landscape, the people, their eagerness to learn, and the opportunity for us to work to help with the new center left a lasting impression.

This relationship with the British Council continued for many years afterward. We ran practical exhibit-making workshops such that we became involved in planning science centers elsewhere. The British Council were also instrumental in bringing visitors from overseas to see the Discovery Dome and arranged return visits. I recall preparing some exhibits for a workshop in India, after such as visit. One exhibit used sticks and string to draw ellipses in the sand. The director of the proposed center, who became a great friend, took me to one side and kindly informed me that villagers will save for years to visit the city. He said that they want to see palaces and wonders, not mess around with sticks in the ground.

This was many years ago and we have since grown as a company with our own science center, traveling exhibitions service and development workshop in London. But, we are still believers in the power of hands-on exhibits to cross cultures and inspire young minds.

The remaining tents of the Discovery Dome now stand with the permanent telescope domes of our Observatory Science Centre which occupies the former telescope domes and buildings of the Royal Greenwich Observatory (RGO) at Herstmonceux, East Sussex in the south-east of England. The telescopes were moved there from Greenwich, London in the 1950s to escape the enveloping lights of the city. The observatory closed in 1990 and we took a long lease on the observatory buildings and grounds to transform the site into a science center with an outdoor exhibit park. The venture to set up a science center and restore the telescopes to full working order was described in one national newspaper as a labor of love, unfolding in the Sussex countryside, and is perhaps the best tribute the center could have as it recognizes the sense of mission. Although the idyllic rural setting away from the city hardly seems an ideal location for a science center in terms of catchment, the mix of hands-on exhibits and the presence of six large telescopes in their exotic domes set around a lily pond make it special and unique. This atmospheric setting contributes in no small part to the fond regard the visitors have for the center.



Our science center opened in 1995 using exhibits from the Discovery Dome.

The center has continued to grow and now has an extensive program of events and workshops including observing evenings and an annual astronomy festival. These events are constantly reviewed and expanded. There are also science shows and guided tours of the telescopes, of which four of the six major instruments have been restored to working order. An interesting feature of the exhibitions is that two exhibition areas are reserved for our traveling exhibitions, which grew from the original Exploring Science exhibition. There are now a total of eleven traveling exhibitions which visit science centers and museums in the UK and overseas as well as the Observatory. Visitor surveys show that the public responds positively to the continual refreshment of the exhibitions. There is also an outreach program using our Science Works curriculum linked table top exhibitions for schools. The Observatory has eleven full-time equivalent staff members plus volunteers. Students are hired during the summer holidays. The attendance has been rising and the center now attracts around 60,000 visitors per year.

The traveling exhibitions are operated from our design and production workshop in London, where we build exhibits for museums and science centers worldwide, as well as for our own projects. The output from the workshop has risen considerably over the years and so have the number of staff. Our workshop now occupies an industrial unit—a far cry from the garage space we started in. The contrast between our somewhat gritty location in London and the rural idyll of the Observatory is quite striking. The work carried out for other museums and science centers helps fund our own projects, which enables the organization to operate without revenue funding from outside. All the activities operate under a not for profit company with charitable status called Science Projects Ltd., which was established in 1987 to raise funds for the Discovery Dome.

This seems to be a good operating model and so far has all turned out rather well. May the adventure continue!

Stephen Pizzey is Founder and Director of Science Projects Ltd., a UK company with charitable status. Further information can be found by visiting www.science-projects.org and www.the-observatory.org

THE CURIOSITY CORNER: A PLACE FOR YOUNG SCIENTISTS TO EXPLORE AND LEARN

Michelle Kortenaar, Tamar Kushnir, and Charlie Trautmann

"Scientists learn about the world in three ways: They analyze statistical patterns in the data, they do experiments, and they learn from the data and ideas of other scientists…Recent studies show that children also learn in these ways." (Gopnik, 2012)

A young child sits at a table, face in deep concentration, as a puppet show is performed just for her. In it, a frog and a penguin place small colorful blocks on the surface of a toy box one at a time. When the frog is playing the box lights up and makes music, and when the penguin plays it doesn't. "Here are some more blocks," says a friendly adult. "I want to know which ones make the toy play music. Who should I ask?""Froggy!" Says the child, smiling, "Because Froggy knows how it works!"

The child watching the puppet show had fun, but she was also learning. Researchers are also learning from the child. She, and others like her, can easily infer from a few observations that the frog made the toy light up because he knew how, and the penguin did not.

This is an example of a now familiar scene at the Sciencenter in Ithaca, New York. Part science research, part science exhibit, this study is part of an NSF-funded project on early childhood learning taking place at Cornell University. In this study, a team of researchers are trying to find out how children use their developing "Theory of Mind"—their ability to think about the mental states (knowing, thinking, feeling, wanting) of other people—to learn new things.

Why Science Museums as Research Centers?

By working at the Sciencenter, Cornell researchers are able to simultaneously recruit and interview child participants for their studies into how children learn, which allows them to do much more than would be possible by asking parents to come in to a university laboratory. But this partnership also greatly benefits the Sciencenter and its visitors. The research takes place on the floor of the Sciencenter's early childhood exhibition-—the Curiosity Corner. Parents, caregivers and educators have the opportunity to see scientific research in action. They can interact with researchers and discuss current theories about how children learn, while observing as children "play" with researchers.

Research in the Curiosity Corner

Across the country, science museums, children's museums, and even natural history museums have been teaming up with researchers at major universities to create "living laboratories" such as ours. These partnerships lead to scientific discoveries while at the same time increasing awareness on the part of parents, caregivers, and educators about the role of science museums in fostering early cognitive and social development.

Children learn everywhere—at home, in playgrounds and preschools. Many adults remember local neighborhoods, playgrounds, and parks as the safe places where, as children, they explored and learned about the world. These days, especially in urban settings, science centers such as ours are the new safe, social space for exploration and learning to take place. Moreover, science and children's museums provide particularly rich environments where learning through exploration is encouraged and expected. When children and their families visit interactive, hands-on museums they find creative, engaging learning experiences. Thus, science and children's museums have for yearsbeen putting the most cutting edge research in developmental science into practice.

The Child as Scientist – Examples at the Sciencenter

Cognitive scientists have for decades been interested in how children learn, and have studied the specific strategies and mechanisms of learning in early childhood. The most recent research shows that children learn much as scientists do: through their play they are experimenting, testing hypotheses and generating causal explanations. Moreover just as scientists do not make discoveries alone, children discover many things through social interaction with one other and by asking for information from helpful, interested, and engaged adults.

The critical lesson from decades of research is that children's scientific minds develop through *exploration*of both the physical and social world. The process of children's scientific learning can be broken down into four interacting learning mechanisms—curiosity, persistence, imitation, and explanation—all of which emphasize either or both *exploratory play* and *social interaction*. Science centers can facilitate this learning by providing interactive exhibits and programs for preschool educators, parents, caregivers, and children. In particular, for our youngest visitors, the Curiosity Corner features safe, hands-on activities, suitable for small bodies, which are specifically designed to facilitate the development of scientific skills through exploration.

The four learning mechanisms can be observed in the young scientist at play—whether she is in the lab or the museum. At times we, as researchers and museum educators, expect young children to explore on their own though play with objects and materials they can touch and see. We also expect that children cannot find out about everything on their own. Thus, in the lab and in the museum space, we offer opportunities for children to use their social capacities to learn—to watch, to question, and to work together.

1. CURIOSITY

The lab: Children are naturally curious about things they don't yet understand, which leads to further exploration. When at play they will gravitate towards objects and events that are unpredictable or unknown (Schulz & Bonawitz, 2007; Cook, Goodman & Schulz, 2011).

Blowing air to make "music"

The museum: Children, at first almost by accident, hold a tube of blowing air up to pipes of different lengths. The unexpected result is sound in differing pitches, a surprise that requires testing. The Curiosity Corner has a variety of unfamiliar objects—things that make unexpected sounds, that have varying textures, that can be manipulated by small hands and that encourage children to safely engage and explore with all of their senses.

2. PERSISTENCE

The lab: Children make inferences about cause and effect gathering *statistical* evidence, using that evidence to predict and explain events in the world around them (Kushnir & Gopnik, 2005; Kushnir, Xu & Wellman, 2010). Thus they often play by persistently repeating the same actions over and over again, and their expectations for the future are based on the statistics of these past experiences.

Playing with water in the Curiosity Corner

The museum: As museum educators, we often notice how children's attention spans can be seemingly much longer than that of their parents. A rubber duck floats down the moving current of the water table—an observation that requires repetitive testing. Children will ask for the same game to be played over and over again. We have designed our Curiosity Corner to have comfortable seating to encourage parents to linger as their children engage in persistent repetition.

3. IMITATION

The lab: Children are precocious imitators of others—when they can't do something themselves they observe others and imitate them. But young children do not just imitate everything they see, but rather they imitate selectively, based on various social and statistical cues. Sometimes children imitate actions with clear goals—actions that are related to interesting effects (Buschbaum, Gopnik, Griffiths & Shafto, 2011). Other times children will imitate just for fun, as a way to bond with others, leading them to learn actions that have no obvious consequences but are nonetheless important (Over and Carpenter, 2012). Thus, imitation is a powerful mechanism for both scientific and cultural learning.

Experimenting with the vacuum tube and foam shapes

The museum: At the air station in our Curiosity Corner, it's not always obvious how the foam shapes are meant to be sucked through a vacuum tube. After failed attempts, we have seen children naturally turn to their parents for guidance; they watch as their parents experiment and figure out what to do. Then the child is ready to take on the role of young experimenter, imitating what they see until they get the desired outcome.

During story time, parents actively engage in the finger play that accompanies songs. Children mimic the adults, moving their fingers to make "itsy bitsy" spiders, clapping their hands in gleeful appreciation. In the make-believe kitchen, children share fanciful meals with their peers—setting the table, serving the "food". Their pretend play thus imitates the events of the past—the meals they've seen made and served in their own homes.

4. EXPLANATION

The lab: Many abstract scientific concepts are invisible and intangible—bacteria and viruses, the movement of planets, animal behavior—preschool children routinely ask questions and seek explanations for these abstract ideas (Callanan & Oakes, 1992; Frazier,

Making observations at the bee hive

"Corner," continued on following page

"Corner," continued from previous pate

Gelman & Wellman, 2009). In fact, the same curiosity that motivates exploratory play also motivates explanation-seeking behavior.They ask "why" when events are unexpected or surprising (Legare, Gelman & Wellman, 2010).

The museum: At the Sciencenter we have a live animal collection. Children watch, fascinated, as bees come and go from their hive, collecting nectar. The unpredictable behavior of the bees elicits much curiosity, and, since they cannot touch or play with them, we have seen children trying to find out more about bees by asking any adult they are with - grilling them with questions from "Where is the queen?" to "Why do they go in and out so much?" to "What's he doing?" This makes for a lively and interactive exhibit where the "expert" is the person who can read the exhibit labels.

Broader Benefits

The partnership with Cornell's Early Childhood Cognition Lab has resulted in other new programs that will benefit the youngest children entering the world of a science museum for the first time. For example, though it is helpful to have a separate space for preschoolers to safely explore and play, very young children and their parents at times would also like to try some of the more sophisticated exhibits that are intended for older kids. Working together, we designed an assignment for an advanced cognitive development seminar at Cornell. The goal was for students to use the concepts they had been studying in class to create a tool to help parents navigate the larger museum in a meaningful way with their preschool-age children. Students created a series of museum "scavenger hunts" for children and parents. Each scavenger hunt used all four of the learning processes discussed above—curiosity, persistence, imitation and explanation. We envision continued refinement of this assignment year after year. It is a good example of the future of our partnership—more ideas useful for Sciencenter guests, for researchers, and for students learning to apply their knowledge of cognitive development in the real world.

These new course projects fit in with other early childhood focused initiatives. Our "Science for Young Minds" program sends museum educators to local preschools to model inquiry-based science and science literacy for educators—giving caring, helpful adults the knowledge they need to scaffold children's scientific growth both inside and outside the museum. Our weekly Story Time, which takes place in the Curiosity Corner, encourages parents and children to explore books and activities with a science theme.

The Sciencenter's mission is "To inspire excitement for science through interactive exhibits and programs that engage, educate, and empower." The collaboration between the museum and Cornell's Early Childhood Cognition Lab has helped to engage young children as they explore and learn. Beyond that, parents, caregivers, and educators are empowered to support children's learning. Researchers and students of cognitive science have also been engaged, educated and empowered as they observe and study children's learning and apply what they've learned in the world outside of the lab.

In conclusion, we believe that partnerships such as this one benefit all-—researchers, science centers, community members, graduate and undergraduate students, and most of all young child scientists. In fact, we believe these partnerships are the premier model for scientific engagement, and can be replicated in a variety of informal educational contexts. We hope others will be inspired to make connections between the worlds inside and outside the science lab.

Future Questions:

As our museum-university collaboration has developed over the past year, we have found three primary challenges, which are listed below. We are actively seeking answers, which will benefit our visitors as well as our research partners:

1. How can we help parents feel comfortable and confident in their role as "knowledgeable" adults when answering their children's questions?
2. How can an exhibit space be designed to encourage more robust and prolonged learning behaviors in our youngest visitors?
3. What are the most effective tools and strategies to give early childhood educators for working with young children?

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Commentary

REFLECTIONS: INTEGRATION OF NEW TECHNOLOGY IN BOTH FORMAL AND INFORMAL EDUCATIONAL SETTINGS

Alexander Zwissler

[Editor's Note: This article was initially published on October 2, 2012, as a blog on the website of the California Association of Museums.]

This past year I had the opportunity to sit on the California State Superintendent of Education's Education Technology Taskforce. Comprised of primarily educators and school administrators (I was an outlier), we had the charge of providing Superintendent Tom Torlakson with a series of strategic recommendations that would help shape his California Education Technology Blueprint; essentially a plan for how to transition, if not transform education in the era of modern technology. Our report can be found here: California State Superintendent of Education's Education Technology Taskforce Report (http://myboe.org/cognoti/content/file/resources/documents/68/6888f59f/6888f59f10eb3403fb69e00110c12515bb735e3a/FinalETTFMemo.pdf).

Some fascinating facts to set the context for our work…currently, it can take up to six years for the State to adopt a new textbook into the approved curriculum. Technologies are born, mature, and then die within that timeframe. A newly introduced text today would not even mention the IPhone, let alone Twitter or the whole App phenomenon. How can a traditional textbook keep up with this pace? Second, while most students, and nearly all by the time they reach high school, are digitally savvy and connected, utilizing and indeed developing new ways to integrate technology into their everyday lives, they are required to turn their devices off in school. So one of the most powerful tools for communication, creativity, information, and learning is shut off by policy in the very setting it could and should be most useful. Finally, instruction continues to be measured and indeed funded by formulas that value hours of time students are sitting in the classroom rather than the quality of the learning.

Clearly some daunting challenges… Combine these with reduced resources, pockets of resistance to change from every corner (teachers, school boards, administrators, textbook publishers, etc.), and an ever changing playing field, more and more at an accelerating pace, one can appreciate the depth and breadth of the challenge for formal education.

And while I encourage you to read our recommendations, and indeed take the opportunity to engage in the process of transformation, for the purposes of our field I think there are some interesting lessons and parallels from these challenges that we should be paying attention to.

First, there needs to be the simple recognition of the fact that the world outside is moving at a pace of change and innovation that our institutions are rarely able to adequately adapt to. I'll use some recent work here at Chabot Space and Science Center as an example. In conjunction with our Bill Nye's Climate Lab, we developed a highly engaging interactive website designed to connect and integrate the visitor experience with the Climate Lab. We used an award winning design firm and indeed created a rich and wonderful site…in fact we were nominated for a Webby for our work….One problem…at the time we started the development of the site, the only robust option for the integration of video into the content (and we had lots of it) was to use Adobe Flash. By the time it was launched, the IPhone and IPad were well on their way towards market dominance, and Apple had made the decision to not support Flash…oops.

So back to the drawing board, we have decided to abandon the site, and migrate the entire online experience to a mobile game format that will be available across all platforms…but here again, even during the time of development, IOS 6 is launched and Amazon comes out with the Kindle Fire. We'll be able to deal with this, but the point is, what will happen 6 months after we launch…after one year? Look around your institution…how many cool digital exhibits or interactives look dated or downright ancient, at least by modern tech standards. The point is, I feel we need to seriously rethink how we go about integrating technology into our exhibit development cycles. One approach is to figure out how to best use our visitor's devices, rather than trying to impose our judgment on which platform will best serve the user…unless we do so, my feeling is that we'll be wrong more often than we'll be right.

Another point from the task force is that in formal education we need to ensure that there is a connection with learning and the real world. A short hand way of thinking about this is moving from theory to practice or applicability. A simple example might be that rather than having lectures on chemistry, have the student work in a lab or a brewery to see and experience the application of chemistry in the real world…Beer! For our field, I feel that too often we do a great job of laying out the theory, and even compelling examples of it, yet rarely connect back out to current applicability. The challenge here is that

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our examples are often static, fixed in time and place (and yes, even if they are "digital"), while the real world is dynamic. Again, tough to keep up, yet that's what is expected of us in today's world.

Finally, another principle from the task-force that I think has some applicability for us is that learning should occur "any time, any place and at any pace". This speaks to the point that learning can, should and does take place at times other than sitting in the class listening to a lecture. In fact, many argue that little real learning occurs in such a setting. Yet like the classroom with its Victorian era constructs, we too often require the museum visitor to take us on our terms rather than meeting them on theirs. I feel that long term this is not sustainable. Like every other content provider (look what's happening in journalism, television, music and yes, text book publishing) if we do not actively participate in our own creative destruction, we will become the victims of its outcomes rather than the master.

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WHAT IS BIODIVERSITY?

Mike Bruton

2010 was the United Nations "Year of Biodiversity", and we are now in the UN 'Decade of Biodiversity' (2011-2020). Yet how many people understand the concept of biodiversity?

One of the challenges facing science centers is to demystify complex issues without dumbing them down so much that they lose their true meaning. I think that we, and the scientific community and popular media at large, are dumbing down the important concept of biodiversity, which is traditionally regarded simply as the number of different species. In fact, to most people, animal diversity is the variety of large, adult vertebrates and familiar invertebrates.

It was recently, and rather triumphantly, announced that an international study has predicted that there are about 8.74 million species of plants and animals on Earth. These include 7.77 million species of animals (of which only about 953,000 have been described) and about 298,000 species of plants; the rest are fungi, single-celled animals and algae. But surely a species count is the crudest measure of this important concept?

Biodiversity should include:

- The diversity of living as well as extinct species.
- The diversity of different life-history forms.
- Diversity above and below the species level.
- The diversity of the relationships between animals, plants and animals, and animals and micro-organisms. These relationships include predator-prey relationships, parasitism, symbioses, commensalisms, pollination, etc.
- The diversity of plant and animal behavior.
- The diversity of habitats, ecosystems and biomes, including soil and water.
- The diversity of human relationships with, and uses of, plants and animals.
- The diversity of domesticated and genetically modified plants and animals.
- The diversity of humans.

Every animal with different life-history stages (e.g. egg-caterpillar-pupa-adult) is effectively more than one ecological species and should be counted several times. Biodiversity should also include the variation within species and especially the extent and nature of the interactions between species, even if this is difficult to measure. Biodiversity isn't a simple, hierarchical Darwinian tree but a complex interlinked web. Perhaps our pattern–forming minds tend to underestimate the messy complexity, and subtlety, of nature.

In fact, biodiversity should be everything that we lose when a species goes extinct, all its interconnectedness as well as the biological memory of the millennia of "research and development" that took place to make it a species in the first place. Defined in this way, we are still a long way from describing the true extent of plant and animal diversity, and measuring our impact on it.

Understanding the concept of biodiversity is essential if we are to comprehend the full impact of humankind on natural species. The IUCN recently estimated that about one third of the 61,900 animal species on their list are now classified as "vulnerable", "endangered", 'critically endangered" or "recently extinct", with some groups, such as the amphibians and reptiles, in particularly rapid decline. They also estimated that as many as 50% of the world's plants and animals could go extinct in the next 100 years at the present rates of decline.

Taxa that have recently gone extinct include a subspecies of the western black rhinoceros, *Diceros bicornis longipes,* from western Africa whereas the northern white rhino, *Ceratotherium simum cottoni*, and the Javan rhino, *Rhinoceros sondaicus*, are almost certainly extinct in the wild. The dugong, *Dugong dugon*, is expected to go extinct within the next 40 years. Fortunately, there are also some good news stories—the southern white rhino, *Ceratotherium simum simum*, is back from the brink of extinction with its numbers increasing from a few hundred at the end of the 19th century to over 20,000 today. Central Asia's Przewalski's horse, *Equus ferus,* has moved from 'critically endangered' to 'endangered'.

Recent research on the economics of biodiversity has revealed that the economic consequences of today's biodiversity loss can be valued at between $1.5 trillion and $3 trillion. Furthermore, environmental economists have estimated the value of the so-called 'free services' that natural plants and animals offer to humans, which could potentially be lost. The pollination of crops, for instance, is valued at $150 billion per year.

Of course, an exciting aspect of biodiversity research is that new species are being discovered every year. The International Institute for Species Exploration at Arizona State University, and an international committee of taxonomists, selects the 'Top Ten New Species' each year. In 2011 this list included a glow-in-the-dark mushroom, a batfish as flat as a pancake, a Titanic-munching bacterium, a leech with enormous teeth, a two-meter long fruit-eating lizard, a jumping cockroach, an orb-web spider whose webs are wide enough to span a river, and a duiker first found in an African bush meat market!

Developing a formula that predicts the true complexity of nature would be the biologist's equivalent of the physicist's 'Theory of Everything'. That's the role of the scientists, but it is our role, as science educators, to provide a true picture of the complexity of biodiversity, and the consequences of its potential loss due to extinction, in our teaching programs.

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NEW EXTINCT MAMMAL ON EXHIBIT IN PAKISTAN

Robert Mac West

The Pakistan Museum of Natural History (PMNH) in Islamabad very recently (October 24) unveiled the installation of a life-sized model of *Baluchitherium osborni*, a huge, 30 million year old, hoofed mammal. This model is based on superb fossil materials found and interpreted by a Pakistani-French team between 2000 and 2003 at a phenomenally rich site in trans-Indus (central-western) Pakistan. Original specimens are on display at the Geological Survey of Pakistan museum in Quetta.

The model is based on careful measurements and arrangement of the fossil bones and was prepared in fiberglass by Pakistani artist Muhammad Asim Mirza in Karachi at a cost of 1.74 million Pakistan rupees, or $18,000 U.S. dollars. It presents *Baluchitherium osborni* as a creature standing 18 feet high at the shoulder and weighing approximately two tons.

Baluchitherium model being installed.

The locality where the fossils were collected was abandoned before work was completed due to political and security concerns. It is now suspected that the site was destroyed in a military action in 2006, and specimens stored in a local chieftain's home also are lost.

The significance of this installation was clearly pointed out by senior officials at the opening ceremony. They indicated that, in the face of serious financial pressures (and a well-known political/military/insurgent environment in contemporary Pakistan), there is a serious effort to promote science and technology in Pakistan and that the museum plays an important role in this.

A release from the Associated Press of Pakistan states the following:

"The (Federal) Minister (for Science and Technology Changez Khan Jamali) lauded the PMNH's efforts in research, documentation, conservation, preservation and display of the natural history of Pakistan as well as its role in public education." "He said this new addition to the displays in the museum will be of immense interest for students and the general public."

"PMNH Senior Operational Manager Akhtar Javed also spoke on statutory functions of the museum and contributions to natural history research and biodiversity conservation as well as public education."

Javed is quoted in an release as stating: "Nowadays education through museums is being regarded as indispensable. PMNH is striving hard for the promotion of informal education through different means, mainly through visitations of school and college students to the Museum Display Galleries."

The PMNH is open six days per week (closed Fridays) from 9:30 to 4:30. Admission is five rupees (U.S. five cents).

[Author's note: I include this brief article in the ILR for a very personal reason. In the late 70s and early 80s I spent the winter months conducting paleontology and geology research in Pakistan and Nepal. I did field work in the area where the *Baluchitherium* quarry is located and am very familiar with social and political circumstances under which the specimens were collected (and likely destroyed). I am delighted with the approach of the museum toward engagement with the public and am very pleased to see (online) visitors of both genders sharing the museum experience.]

Robert Mac West is the editor and publisher of The Informal Learning Review. He may be reached at ileinc@informallearning.com.

NEW ANNUAL PUBLICATION

Exhibit designer Seth! Leary inaugurated an annual publication at this year's ASTC conference in Columbus, OH. *Exhibit* is (in its inaugural issue) a 24-page, full-color overview of various exhibit initiatives (of course, including several of those done by Seth!). In addition, the 2012 issue includes a commentary on the 50th anniversary of the Pacific Science Center, a visit to the Wabash & Erie Canal Park in central Indiana, and a trip that Seth and his son took on U.S. Route 66 through central and southwestern United States that resulted in a traveling exhibit by the same name.

Leary is making this magazine available to interested parties at no cost. It is available in hard copy as well as at www.exhibitmagazine.com. Contact him at NRG! Exhibits, 10922 126th Place NE. Kirkland, Washington 98033, or seth!@nrg-exhibits.com.

THE 2012 IG NOBEL PRIZE WINNERS

Winners were announced and awarded on Thursday night, September 20. The ceremony was webcast live. For more information, check the “ceremony page” on www.improbable.com.

Psychology Prize: Anita Eerland and Rolf Zwaan (The Netherlands) and Tulio Guadalupe (Peru, Russia, and The Netherlands) for their study "Leaning to the Left Makes the Eiffel Tower Seem Smaller."

Reference: "Leaning to the Left Makes the Eiffel Tower Seem Smaller: Posture-Modulated Estimation," Anita Eerland, Tulio M. Guadalupe and Rolf A. Zwaan, Psychological Science, vol. 22 no. 12, December 2011, pp. 1511-14.

Attending the Ceremony: Tulio Guadalupe. (Note: Two days after the ceremony, Anita Eerland and Rolf Zwaan will marry each other, in the Netherlands.)

Peace Prize: The SKN Company (RUSSIA), for converting old Russian ammunition into new diamonds.

Attending the Ceremony: Igor Petrov

Acoustics Prize: Kazutaka Kurihara and Koji Tsukada (Japan) for creating the SpeechJammer — a machine that disrupts a person's speech, by making them hear their own spoken words at a very slight delay.

Reference: "SpeechJammer: A System Utilizing Artificial Speech Disturbance with Delayed Auditory Feedback", Kazutaka Kurihara, Koji Tsukada, arxiv.org/abs/1202.6106. February 28, 2012.

Attending the Ceremony: Kazutaka Kurihara and Koji Tsukada.

Neuroscience Prize: Craig Bennett, Abigail Baird, Michael Miller, and George Wolford (USA), for demonstrating that brain researchers, by using complicated instruments and simple statistics, can see meaningful brain activity anywhere — even in a dead salmon.

Reference: "Neural correlates of interspecies perspective taking in the post-mortem Atlantic Salmon: An argument for multiple comparisons correction," Craig M. Bennett, Abigail A. Baird, Michael B. Miller, and George L. Wolford, 2009.

Reference: "Neural Correlates of Interspecies Perspective Taking in the Post-Mortem Atlantic Salmon: An Argument For Multiple Comparisons Correction," Craig M. Bennett, Abigail A. Baird, Michael B. Miller, and George L. Wolford, Journal of Serendipitous and Unexpected Results, vol. 1, no. 1, 2010, pp. 1-5.

Attending the Ceremony: Craig Bennett, Abigail Baird, Michael Miller, and George Wolford.

Chemistry Prize: Johan Pettersson (Sweden and Rwanda), for solving the puzzle of why, in certain houses in the town of Anderslöv, Sweden, people's hair turned green.

Attending the Ceremony: Johan Pettersson.

Literature Price: The US Government General Accountability Office, for issuing a report about reports about reports that recommends the preparation of a report about the report about reports about reports.

Reference: "Actions Needed to Evaluate the Impact of Efforts to Estimate Costs of Reports and Studies," US Government General Accountability Office report GAO-12-480R, May 10, 2012.

Physics Price: Joseph Keller (USA), and Raymond Goldstein (USA and UK), Patrick Warren, and Robin Ball (UK), for calculating the balance of forces that shape and move the hair in a human ponytail.

Reference: "Shape of a Ponytail and the Statistical Physics of Hair Fiber Bundles." Raymond E. Goldstein, Patrick B. Warren, and Robin C. Ball, Physical Review Letters, vol. 198, no. 7, 2012.

Reference: "Ponytail Motion," Joseph B. Keller, SIAM (Society for Industrial and Applied Mathematics) Journal of Applied Mathematics, vol. 70, no. 7, 2010, pp. 2667–72.

Attending the Ceremony: Joseph Keller, Raymond Goldstein, Patrick Warren, Robin Ball.

Fluid Dynamics Prize: Rouslan Krechetnikov (USA, Russia, Canada) and Hans Mayer (USA), for studying the dynamics of liquid-sloshing, to learn what happens when a person walks while carrying a cup of coffee.

Reference: "Walking With Coffee: Why Does It Spill?" Hans C. Mayer and Rouslan Krechetnikov, Physical Review E, vol. 85, 2012.

Attending the Ceremony: Rouslan Krechetnikov.

Anatomy Prize: Frans de Waal (The Netherlands and USA) and Jennifer Pokorny (USA) for discovering that chimpanzees can identify other chimpanzees individually from seeing photographs of their rear ends.

Reference: "Faces and Behinds: Chimpanzee Sex Perception" Frans B.M. de Waal and Jennifer J. Pokorny, Advanced Science Letters, vol. 1, 99–103, 2008.

Attending the Ceremony: Frans de Waal and Jennifer Pokorny.

Medicine Prize: Emmanuel Ben-Soussan and Michel Antonietti (France) for advising doctors who perform colonoscopies how to minimize the chance that their patients will explode.

Reference: "Colonic Gas Explosion During Therapeutic Colonoscopy with Electrocautery," Spiros D Ladas, George Karamanolis, Emmanuel Ben-Soussan, World Journal of Gastroenterology, vol. 13, no. 40, October 2007, pp. 5295–8.

Reference: "Argon Plasma Coagulation in the Treatment of Hemorrhagic Radiation Proctitis is Efficient But Requires a Perfect Colonic Cleansing to Be Safe," E. Ben-Soussan, M. Antonietti, G. Savoye, S. Herve, P. Ducrotté, and E. Lerebours, European Journal of Gastroenterology &Hepatology, vol. 16, no. 12, December 2004, pp 1315-8.

Attending the Ceremony: Emmanuel Ben-Soussan.

Not all of the Ig Nobel Prizes are shown. Visit http://www.improbable.com/ig/winners/#ig2011 for more.

"Citizen," continued from back cover

eas in order to help scientists determine how and why the ranges of various economically and ecologically important species of ladybugs are currently rapidly changing.

- The Community Collaborative Rain Hail and Snow Network measures and maps rain, hail and snow levels throughout the United States. Users of this organization's data include the National Weather Service, meteorologists, hydrologists, emergency managers, city utilities (water supply, water conservation and storm water), insurance adjusters, the USDA, engineers, mosquito control, ranchers and farmers, outdoor enthusiasts, teachers, students and local residents.
- The Citizen Sky Program solves mysteries involving the cyclic dimming of a particularly bright star known as Epsilon Aurigae, based, in part, on nightly observations of the star's brightness that are recorded by citizen scientists using everything from the naked eye to high-tech equipment.
- The editor of *Sky & Telescope* discussed the importance of contributions made by citizen scientists to the development of recent new insights about Epsilon Aurigae in two video interviews, as well as the particular importance of recruiting citizen scientists into astronomical research during periods of shrinking research budgets. In addition, the March 2012 issue of *Sky & Telescope* features an article covering this topic.
- Einstein@Home uses donated time from the home and office computers of 250,000 volunteers from 192 countries to help process the enormous amounts of data that are generated in the search for various astronomical phenomena. The program has helped scientists discover about one new pulsar per week throughout 2012.
- Quake-Catcher Network links the computers of volunteers into a network that sifts through seismic signals and helps determine whether detected motions represent earthquakes or cultural noises, such as slamming doors and the motions of large trucks. Recently, the Quake-Catcher Network detected a tremor 10 seconds before the shaking reached Stanford University's campus.

The Sustainable Prisons Project forges collaborations between scientists, inmates, prison staff and others to enable inmates to conduct ecological research and conserve biodiversity. An NSF press release features the Moss-in-Prisons project at Cedar Creek Corrections Center, a medium security prison in Littlerock, Washington.

A Real Example

To bring this down to earth, here is the material distributed by the Ithaca, New York, Paleontological Research Institute about its focused citizen science program, the Mastodon Matrix Project.

goal — Help paleontologists study past environments.

task — Analyze actual samples of fossil matrix mailed to your home.

The Mastodon Matrix Project needs citizen volunteers to analyze actual samples of matrix (the dirt) from a 14,000 year old mastodon excavated in New York! Learn the process of science and work like a paleontologist on real research material!

Volunteers sort through the matrix to find shells, bones, hair, pieces of plants, and rocks from the time when the mastodons lived and roamed the Earth. The matrix and discoveries are then sent back to the Paleontological Research Institution, where they will be cataloged and further analyzed by paleontologists to help scientists form a true picture of the ecology and environment of the late Pleistocene.

Mastodons are extinct relatives of modern elephants. Mastodons were numerous and widespread in North America up until around 10,000 years ago, when they became extinct--with many other species--at the end of the last glacial period.

Mastodon skull at the PRI
Photo: Paleontological Research Institution

Participation fee	$18
Expenses	$ 0
Spend the time	outdoors
Location	anywhere
Children	yes
Primary school	yes
Secondary school	yes
Teaching materials	yes

Required Gear:

Matrix is shipped to your organization in one kilogram bags - one kilogram will be enough for about 20-25 participants.

To analyze the matrix, you will need the following gear: newspapers, paper plates, toothpicks, a magnifying glass, and plastic baggies/jars with wide mouths and tight fitting lids. Also helpful are: one or more embroidery hoops with a piece of scrim (or other gauzy curtain material), a clean fine mesh or grease splatter screen, a scale, a low-power microscope, an overhead projector, an old toothbrush, paper towels, coffee filters, and a colander or funnel.

Resources and Step-by-step instructions on how to conduct the analysis will be mailed with your order, and can also be found here: http://www.museumoftheearth.org/research.php?page=Mastodon_ Research/Mast_Matrix

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CITIZEN SCIENCE – GROWING, EXPANDING, CONTRIBUTING

Robert Mac West

For the past several years, the concept of citizen scientists working as integral parts of scientific research projects has become increasingly popular and pervasive. What previously was a minor aspect of specimen and data collection and processing has evolved significantly. Many scientists and institutions have quickly realized that using the enthusiasm and skills of numerous citizens can greatly expand their data-gathering and processing capabilities and, upon occasion, introduce new concepts and approaches into a research project.

The US National Science Foundation has recognized the importance and effectiveness of using the massive resource of the broad public to expand research projects and now regularly funds a large variety of citizen science projects. An April 2012 post of the NSF describes a sample of the projects currently being supported (http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=123903): Top of Form

- The USA National Phenology Network brings together citizen scientists, government agencies, nonprofit groups, educators and students to monitor the impact of climate change on plants and animals in the U.S. Many scientific papers on changes in the timing of seasonal events have been based on this group's data.
- Project Budburst engages the public in collecting data on the timing of the leafing, flowering and fruiting of plants in the United States. Data generated by Project BudBurst was recently used to help validate models of the timing of cherry blossoms in Washington, D.C., and the mid-Atlantic states in the presence of climate change.
- Projects sponsored by the Cornell Lab or Ornithology help researchers better understand birds and their habits via varied programs involving inventories of the abundance and distribution of birds over large distances; analyses of how birds are affected by climate change, urbanization and land use; the development of new methods for identifying birds; and advice for individuals for converting their backyards into bird-friendly habitats.
- Much of the data included in the Department of Interior's annual State of the Birds report for 2011 originated from Cornell's citizen science programs. The report helps public agencies identify significant conservation opportunities in various habitats.

The Coastal Observation and Seabird Survey Team collects data on beached birds found on more than 300 beaches from the north coast of California to Alaska in order to help monitor ecosystem health.

- The Lost Ladybug Project recruits residents of geographical areas throughout the United States to submit photographs of ladybugs from their local ar-

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