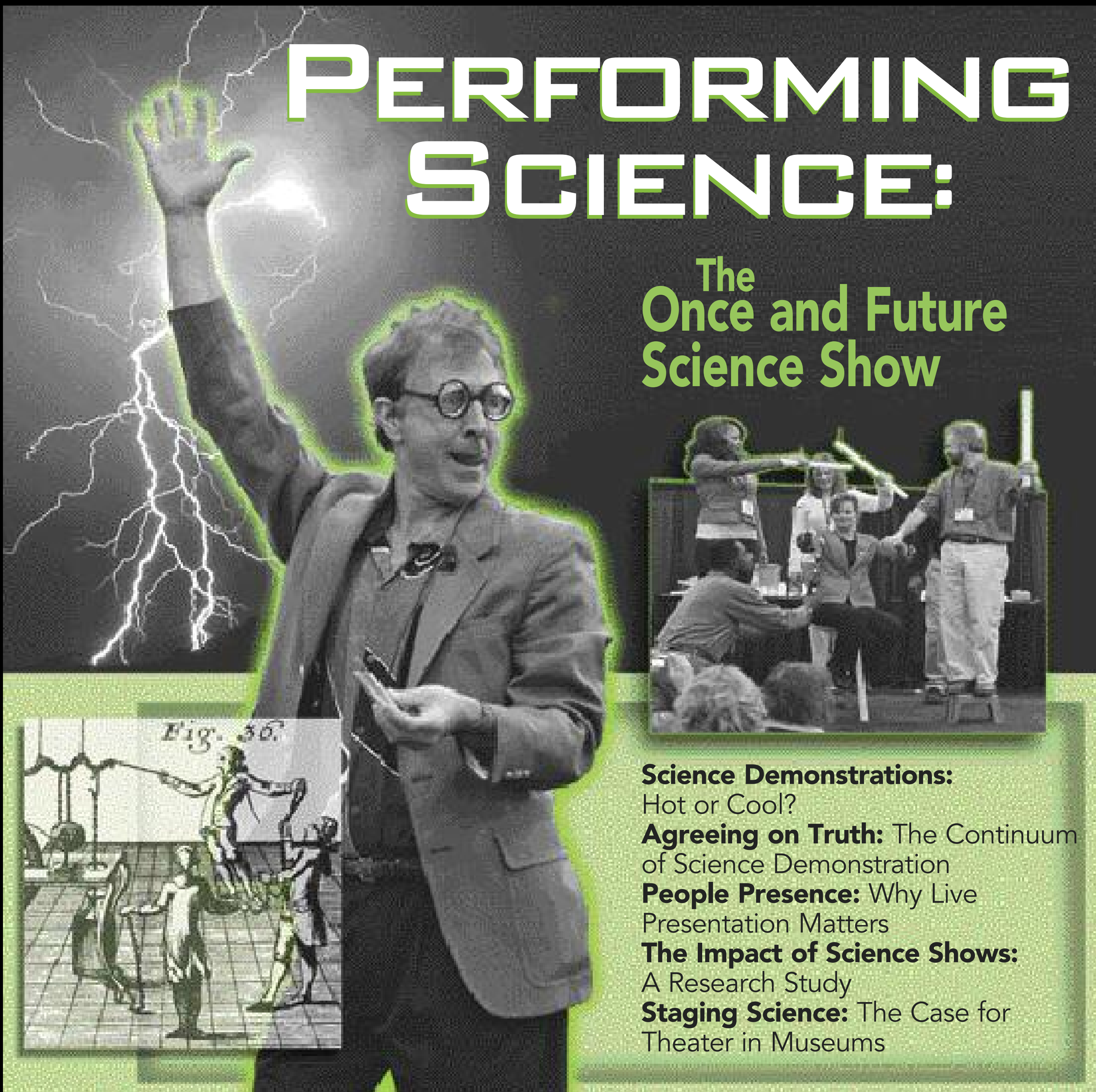
ASTC Dimensions

Bimonthly News Journal of the Association of Science-Technology Centers

March/April 2007



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Historically, showmanship and science have been a popular combination in science centers. More than 91 percent of ASTC-member museums feature "classes and demonstrations" in their programming, and some of the larger museums also support a science theater program. But do these events make a lasting impression on visitors? Which techniques are most effective? How is the classic science show changing (or needing to change) to reach today's audiences? What can science centers do to refresh their live science programs? In this issue, we look back to the roots of science performance, share some research findings, and examine how some ASTC members are reinventing the science show.

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Cover: In the age of YouTube and Mythbusters, does live presentation still have a place in science centers? As much as ever, say today's museum educators—and visitors. *Images, left to right:* In a 1775 engraving by L.S. Jacquet de Malzet, three gentlemen test the effect of chains and a rod on the "circle shock" received from a Leyden jar. During the Live Demonstration Hour at ASTC 2006, host Eddie Goldstein performs as "Professor Vincente," and a team from the National Science Center, Augusta, Georgia, led by Waymon Stewart (kneeling, left), uses a Tesla Coil to light a group of fluorescent and incandescent light bulbs. *Illustration courtesy Bakken Museum; photos by James Moses/ASTC 2006*

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Science Demonstrations: *Hot or Cool?*

By Eddie Goldstein

In college, I took a course where we studied the work of Marshall McLuhan. I have continued to make use of this 20th-century media analyst and communications theorist's ideas over the years—especially his concept of "hot" and "cool" media. What I will write here is more my own interpretation and restatement of McLuhan's ideas, applied to current situations, than his exact wording. But I believe that the concept of hot and cool media has a lot to tell us about our culture in general and science center programs in particular.

Herbert Marshall McLuhan, longtime professor of English at the University of Toronto, was one of the first people to study how different media affect us, irrespective of the content transmitted by those media. (As the man who coined the phrase "The medium is the message," he would recognize, for instance, that the very act of carrying a cell phone changes one's life in distinct ways, no matter what conversations you have on that phone.) In his 1964 book *Understanding Media,* McLuhan wrote about his concept of direction of information flow.

Media in which the information flows from the medium to the user, he said, was "hot"—like a physically hot object from which energy flows outward to the environment. By contrast, media in which the information flows from the user back to the medium, McLuhan called "cool"—like a cool object that pulls heat energy from the environment.

Armed with these ideas, it is possible to see how science centers can create exhibits, programs, and demonstrations that are intentionally hot or cool. One is not better or worse than the other, but each has a distinctive effect on visitors.

In "hot" demonstrations like the Denver Museum of Nature & Science's saga of nasal function, "The Good, the Bad, and the Yucky," information flows from the presenter(s) to the audience. *Photo by James Moses*

Hot and cool in the museum

Within the museum environment, *hot* media are represented by lectures, exhibit labels, most computer kiosks, and information-delivering demonstrations. In all of these examples, information is going "out" from the medium to an essentially passive audience. Even when you ask people at a science demo to call out answers to fact-oriented questions, you are not really interested in getting novel ideas from them so much as in having them give the "correct" answer. Soliciting audience response in this manner is a thinly disguised way for the presenter to give out information. With hot media, most visitors get essentially the same experience.

Cool media are represented in the museum by inquiry-based exhibits, brainstorming sessions, and creative arts-and-crafts-type activities. In each of these examples, what the visitor puts into the exhibit, program, or activity is the essential character of the experience.

A brainstorming facilitator gathering ideas from his or her audience is quite different from a demonstrator asking for specific answers to questions. Not only does information flow *from* the user *into* a cool medium, but the medium is actually a tool for the visitor to process his or her own information, and the experience is guided by the visitor.

With cool media, different visitors will usually have different experiences. Put a blank canvas and some paints in front of 10 separate people, and you will get 10 separate results. That doesn't mean an experience developer can't structure the experience. Provide a small canvas with tiny brushes or a giant canvas with spray cans of paint, and you will influence the type of paintings visitors create.

One of the most powerful examples of a "cool" exhibit experience I have encountered was in the *Field to Factory* exhibition at the National Museum of American History. The exhibition, which closed last March after a 19-year run, dealt with the experiences of African Americans who moved from the rural South to the industrialized North between 1915 and 1940.

At one point, in order to enter the next room, visitors had to pass through one of two doors—one labeled "WHITE" and the other,

Creating Dynamic Space: The Virtual Stage

When we developed *Space Odyssey*, a permanent gallery at the Denver Museum of Nature & Science (DMNS), we wanted the space to be optimal for performing programs as well as for displaying exhibits. The solution was to create locations within the gallery that can be turned into a stage with the push of a button, yet disappear when a program is over.

These "virtual stages" are valuable because they allow a space to have multiple functions. When not set up for a program, they don't look like empty real estate. They can be used for scheduled performances, and they can accommodate impromptu responses to visitors' needs. In short, they make the exhibition as a whole much more dynamic.

A critical element for any successful presentation is that everyone can see and hear. At its most basic, a virtual stage requires only lighting and voice-amplifying sound that can be turned on and off by staff. At DMNS, we were fortunate to be able to build these technologies into a new gallery. But they can also be installed easily and inexpensively in a preexisting space.

Lights can be attached to the ceiling and focused at a 45-degree angle to the "stage." This both defines the space and enables visitors to see well. Effective sound can be accomplished with lower-volume speakers pointed straight down instead of louder speakers pointed out from the stage. The performer wears a wireless mike. None of these items are noticeable when not in use.

Another versatile, but not necessary, piece of equipment for a virtual stage is a media screen. At DMNS, we make use of a variety of screens that are already part of the gallery. After loading program content onto a laptop, the demonstrator plugs into a wall socket, flips a switch, and takes over the exhibit screen for a program. Another solution would be to have a video projector mounted in the ceiling and pointed at a blank part of the wall.

The two photos shown here illustrate the uses of one of *Space Odyssey*'s virtual stages. At left, the demonstrator uses an oversized book as the main content focus. The pool of light creates the stage, and the wireless mike completes the picture. This works well late in the day, when there are fewer visitors in the gallery.

In the photo below, a screen comes down from the ceiling and is connected to a laptop computer on rolling cart. This can be used for prepared visuals or to connect to the Internet. (If you haven't tried it, don't underestimate the power of surfing the Web in an informal, yet guided manner with a group of visitors.)

These are just two of the many options you will discover for yourself when you add a virtual stage to your exhibit space. *—Eddie Goldstein*

Photos courtesy Denver Museum of Nature & Science

"COLORED." The first time I saw this, a flood of memories filled my head. I recalled that when I was about 10 or 11, we visited my cousins in Charleston, South Carolina. In that city, I noticed, there were often three restrooms in a public place: "Men," "Women," and "Colored." That made quite a negative impression on me at the time. Now, here I was in the Smithsonian, having to choose which door I would walk through.

The exhibit forced me to process my own set of memories and thoughts, which would naturally be quite different from those of any other visitor. As strong as the moment was emotionally, it was a "cool" experience, according to McLuhan, because it encouraged active mental participation on my part to complete the experience and deliver the message.

The Creative Problem Solving Show

So how does one use all of this for developing science demos? Most readers of this article have probably had experience in creating "hot" demos, the ones where the presenter is basically showing or telling the visitors information. Most of the shows I create at the Denver Museum of Nature & Science (DMNS) fall into this category. Instead, let me focus on a "cool" demonstration: the "Creative Problem Solving" show that we do at DMNS.

The idea for the show came a few years ago when I was consulting at the Birla Science Center in Kolkata, India. One of their science demonstrators showed how two pieces of paper, when dropped, float to the floor at about the same speed. But if he crumpled one up, it dropped much faster, due to the reduced air resistance. The whole demonstration took about 25 seconds.

I thought that there must be more you could do with that. When it was my turn on the stage, I took two pieces of paper and asked how to make the right-hand one hit before the left one. The audience quickly called out that I should crumple the right piece.

"OK," I said. "Now, what is *another* way to do it?" *Hmm.* After a brief pause, someone called out another answer. We spent the next 15 minutes coming up with all sorts of ways to accomplish it. A real breakthrough occurred when someone suggested dropping the right piece, waiting, and then dropping the left piece. (I had purposely worded the challenge so answers like that could be included.) At that point, the floodgates opened.

Think about what was going on with this demonstration. I was not the information provider; I was the information receiver. This was a cool medium. My role was basically to be the "lab assistant" for all of the "scientists" in the audience.

This is how the show works in Denver. We have a few introductory slides about thinking outside the box. Then we go into the challenge with the paper. Although I am only the lab assistant, there is plenty of room for me to put in ideas and suggest experiments. Quite often someone will suggest putting a weight on the right-hand paper. Before I do the experiment, most audience members think the paper with the weight will fall faster. (It does.) When I ask, "Why?" they often say it is because it weighs more. I then crumple the left-hand paper and repeat the experiment. Now both hit at the same time.

This can lead the audience to suggest other experiments. Of course, different groups will come up with many of the same ideas. But to each new audience, it feels as if the whole show is spontaneous, unique, and, most importantly, guided by them.

Moving from "hot" to "cool"

Would you like to give this technique a try? Right now, think of an exhibit you already have that is inquiry-based. Often, that exhibit will have been designed so a visitor or a small group can work it independently. Instead, go out on the floor near that exhibit, call a group of visitors over, and "show" them the exhibit.

Rather than having *them* manipulate the objects, let them suggest things for *you* to try, and then facilitate their curiosity. When you come up with something you like, try it with a larger group or even on stage. The idea is for the audience to feel that *they* are doing the "experimenting," even though you are manipulating the objects.

Both "hot" and "cool" demonstrations can be excellent ways of engaging science center visitors. Just be aware that they have different impacts on the audience. Experiment by adding cool demonstrations to your repertoire, and see what happens when you encourage entire audiences to engage in the type of inquiry-based learning that normally goes on only at individual exhibit stations.

Go on. Give it a try. ■

Eddie Goldstein is senior educator/coordinator for science gallery programs at the Denver Museum of Nature & Science, Denver, Colorado: www.dmns.org. *For more than 15 years, he has also organized and hosted the Live Demonstration Hour at the ASTC Annual Conference.*

Performing Science: A Demo and Drama Sampler

Carpenter Science Theatre Company
www.smv.org/nowshowing/cst
Plays developed by the resident theater at the Science Museum of Virginia, Richmond, include *Mysteries of Plasma: The Charles Drew Story* and *Shakespeare and Galileo. At the End of the Wire,* a drama set at the 1893 Chicago World's Fair, opens in June. Scripts available on request; contact director Larry Gard, lgard@smv.org.

DragonflyTV
http://pbskids.org/dragonflytv/superdoit/index.html
DragonflyTV, the television series from Twin Cities Public Television that is currently taping shows in science centers, has some 50 "Do It" videos on its web site, aimed at audiences aged 9–13.

Famelab
www.famelab.org
Contestants audition at science centers for this annual competition to find the United Kingdom's best science communicators. The final contest is held at the Cheltenham Science Festival in June. View video profiles and podcasts online.

Iron Science Teacher
www.exploratorium.edu/iron_science
Parodying the cult Japanese TV show "Iron Chef," the Exploratorium's Iron Science Teacher competition webcasts Bay Area science teachers as they devise demonstrations around a particular ingredient. A complete archive of past webcasts is available on the site.

Mythbusters
www.discoverychannel.co.uk/mythbusters
The popular Discovery Channel TV series combines science, special effects, and technology, as hosts Jamie Hyneman and Adam Savage test the validity of popular myths and legends.

Science on Stage
www.esa.int/SPECIALS/Science_on_Stage/index.html
Science on Stage will hold its second festival April 2–6 in Grenoble, France. 500 outstanding European teachers of physics, chemistry, and biology, selected by audition, will share their best approaches and ideas.

Shell Questacon Science Circus
www.questacon.edu.au/html/sqsc.html
Sixteen graduate students in Science Communication staff a program, which tours regional Australia for 18–20 weeks a year, offering lively presentations, portable science exhibits, and teacher training. A history of the Science Circus, *Making a Difference*, plus show summaries and sample demonstrations, can be found here.

Spectrum Drama
www.spectrumdrama.com
The 20-year-old resident theater company at London's Science Museum and Natural History Museum, Spectrum Drama recently produced *Push Harder, Mr. Jones,* a forum theater piece on male pregnancy, and *Back to the Future 3–Don't Try This At Home,* an annual live chemistry show presented at the Royal Albert Hall.

Steve Spangler Science
www.stevespanglerscience.com/video
Museum educators recommend the live demos from Spangler's TV show; dozens of video podcasts can be viewed here.

—Compiled by Carolyn Sutterfield

Agreeing on Truth:

The Continuum of Science Demonstration

By Richard Toon

A visit from an itinerant science demonstrator was the inspiration for the 1768 English painting, *An Experiment on a Bird in the Air Pump.* *Joseph Wright of Derby/©Visipix.com*

It's a striking image. In a darkened room, a single candle illumines nine figures gathered round a table. A child glances up in apprehension; another hides her face in her father's coat. A couple flirts in the corner. At the center the wild-haired experimentalist works his apparatus—his hand raised dramatically above a glass globe in which a white cockatoo flutters weakly.

The painting is *An Experiment on a Bird in the Air Pump,* a 1768 work by English artist Joseph Wright of Derby that now hangs in London's National Gallery. The scene it depicts is the precursor of a phenomenon we know well today—the public science demonstration.

From esoteric to popular science

In the modern science center, science shows are presented in a variety of settings: on mobile carts, on tabletops in exhibit areas, in specially built and equipped theaters. The commonly used term "live demonstration" emphasizes the person-to-person nature of the experience. But while science performance is ubiquitous, its earlier—and much longer—history as a means of understanding natural principles is perhaps not so well known.

At Oxford University, public demonstrations of science at the Ashmolean Museum actually predated the teaching of science to students. Willem Hackmann, writing about the Ashmolean in 1992,[1] described the 17th-century museum as "the first of the science centers," containing not only "specimens from all creation, as in Noah's Ark," but also a chemical laboratory in the basement and space for lectures and demonstrations given in the museum's School of Natural History.

A similar function was served by the Royal Society of London (founded in 1660), where experiments were conducted before members, who then recorded their observations and comments in a book provided for this purpose. In an age before standards were established for writing and publishing scientific experiments and their findings, it was necessary to create audiences of "credible gentlemen" (members of the Society and their distinguished guests, only rarely female) as witnesses who could verify and authenticate what took place.

This process of public demonstration and verification, described by Steven Shapin in his 1996 book *The Scientific Revolution*[2] as the "making of an experimental fact," was an accepted way for new discoveries to enter the lexicon of science in the early modern era. One of the best documented of these demonstrations was conducted in 1659 by Robert Boyle before what would become the Royal Society. Boyle showed the properties of vacuums, using an air pump device constructed for him by his assistant Robert Hooke. (This very air pump

1. Hackmann, Willem. "'Wonders in One Closet Shut': The Educational Potential of History of Science Museums." In John Durant, ed., *Museums and the Public Understanding of Science.* London: Science Museum, in association with the Committee on the Public Understanding of Science, 1992.

2. Shapin, Steven. *The Scientific Revolution.* Chicago: University of Chicago Press, 1996.

remained for many years the showpiece of the Society, often demonstrated for favored guests.)

Public witness of scientific truth continued for at least another hundred years before scientific journals took its place. Benjamin Franklin's well-known experiments with electricity, undertaken from 1747 to 1750 (and published by the Royal Society in 1751), were performed in collaboration with friends and neighbors.[3]

That science demonstrations gradually made their way from socially restricted circles into more popular culture we know from a number of contemporary sources, one of which is *An Experiment on a Bird in the Air Pump.* No longer, the painter shows us, are the witnesses to science limited to scholars and gentlemen. Only a century after Boyle, the general availability of beautifully crafted scientific instruments like the air pump has made possible what we see here—a well-to-do English family hosting a science experiment in their own parlor.

Barbara Stafford, a scholar who specializes in Enlightenment-era art and science, writes that it was, in fact, a mid- to late-18th-century fad in England for people to invite independent, often itinerant "natural philosophers" into their homes to demonstrate the laws of nature for the "rational recreation" of the household.[4] Stafford describes the central figure in Wright's painting as a "conjurer-scientist," surrounded by a group of male and female children and adults "whose reactions range from distress to disinterest to absorption." (A mixed reaction to science demonstration is clearly perennial.)

Two features of this 18th-century custom help shed light on modern science performance. First, an important part of the presentation was to show the correct way to do an experiment. Second, and more importantly, the artificially produced effects were to be understood and received as a reflection

3. Krider, E. Philip. "Benjamin Franklin and Lightning Rods." *Physics Today.* American Institute of Physics, January 2006.
4. Stafford, Barbara M. *Artful Science: Enlightenment Entertainment and the Eclipse of Visual Education.* Cambridge, Mass.: MIT Press, 1994.

Shockin' at The Bakken

By David J. Rhees

Hardly a day goes by at the Bakken Library and Museum (The Bakken) in Minneapolis when groups of children and adults do not participate in one of the classic science demonstrations of the 18th century—the electrical "circle shock."

The Bakken was founded in 1975 by Earl Bakken, inventor of the first transistorized pacemaker. The museum, which is housed in an expanded Tudor mansion, has one of the world's leading collections on the history and science of electricity. Surrounded by antique electrical instruments and books, visitors reenact each day many of the same experiments that Benjamin Franklin conducted in the mid-1700s for the amusement and enlightenment of his friends.

The circle shock demonstration evolved from the investigations of European natural philosophers into the newly discovered properties of static (frictional) electricity. Sending a shock through a circle of people holding hands first became possible in 1745–46 with the invention of the Leyden jar, a device—essentially a capacitor—that permitted the temporary storage of a large electrical charge.

Field trip students at the Bakken make their own small "Leyden jars" by wrapping a plastic film container with foil, filling it partly with water, and pushing a nail (for an electrode) through the cap. The maker charges the jar with a crank-operated electrostatic generator and then, holding the jar carefully by its circumference, joins hands with other

P.J. Windler's 1747 treatise on electricity contains one of the first images of sending a shock through a circle of people holding hands. *Illustration courtesy Bakken Museum*

students in a circle. The last one completes the circuit by touching the electrode. Voila! All receive a shock at the same moment.

Eighteenth-century scientists quickly enlisted the public to demonstrate this amazing phenomenon and to answer questions such as *How many people can be shocked? Must they be insulated from the ground? Would it work if people were separated by a glass rod, a wooden stick, a metal wire, a small air gap, even a river? How fast does the electrical charge flow?*

A sort of race developed to shock the most people. Franklin shocked 22 of his dinner guests at one of his "electricity parties." Louis-Guillaume Le Monnier electrified 140 courtiers before the King of France, and the Abbé Nollet shocked 180 gendarmes before the same royal audience. Nollet also shocked a line of 200 Carthusian monks at their monastery, noting, "It is singular to see the multitude of different gestures, and to hear the instantaneous exclamation of those surprised by the shock."[1] Even in this early period, the element of amusement and spectacle was as important as the desire for scientific progress.

The circle shock is just

The Bakken's Great Hall is a frequent venue for circle shocks with large groups. *Photo by Bruce Challgren*

1. Heilbron, John. *Electricity in the 17th and 18th Centuries.* New York: Dover, 1999.

(Continued on page 8)

of nature. The use of artificial experimentation required, as Shapin describes it, "accepting the principle that the products of human art could and did stand for the order of nature." Indeed, only when there was general acceptance of the experimental process and its results could there be a reliable inference about the larger order of nature.

A modern witness to truth

Eventually, experimentation was conducted more and more in private laboratories, with little or no public access, and museums like the Ashmolean became places that merely presented and interpreted science done elsewhere. But this glance at the history of scientific experimental method helps us to see that the fact-making process is still part of science performance today.

Unlike an interactive science exhibit, which is public but mainly individual, the contemporary science demonstration is public and collective. Through the use of special apparatus, phenomena that are perhaps not able to be directly and easily observed can be artificially and safely summoned and their properties explored and explained before a museum audience. The cow eyeball dissection performed thousands of times per year in science museums, for example, unfailingly reveals inner structure and function of the eye to an audience assembled to witness the objectivity of scientific method and the construction of its scientific "facts." Likewise, demonstrations of static electricity or liquid nitrogen serve both to illustrate the science and to model appropriate behavior with dangerous phenomena.

In the demonstrations of Boyle's and Franklin's eras, it was fundamental to the understanding of science that the link between the artificially created event and the general principle be accepted. The experimenter was careful to make that connection.

One might think that science centers would also consciously strive to make this link clear to audiences, particularly when those audiences include children. Yet it is rarely done. The demonstrator perhaps too often remains the "conjurer-scientist." To the extent that we have isolated science demonstration in large, purpose-built institutions and directed it mainly toward children, I think we have perpetuated an experience that is little different from the images in Joseph Wright's painting.

Despite the tremendous developments in scientific method and discovery over the last three hundred years or so, nonscientific audiences at public science performances still can be witnesses to experimental "fact making." At best, science center demonstrations can allow not just the discovery and witness of natural principles, but also the opportunity to experience how truth is publicly agreed upon and, in a sense, constructed.

The artificial experiment did not in 1659, and does not now, in and of itself make its own case. Science performers may need to ask themselves and share with their audiences answers to the kind of questions addressed by 17th-century science: What is an experiment? Why does one do experiments to arrive at scientific truth? What recommends the experimental way in science over alternatives to it? In this way, science center audiences, too, can play the active role of witnesses to the scientific facts created and laid before them.

The process by which we agree on truth is still contested by philosophers and sociologists of science. But it has its roots in the experimental methods of those first science demonstrations witnessed only by the privileged few, as well in the "rational recreations" of the middle classes, as shown in Wright's painting. That history, in addition to more contemporary methods of constructing truth, needs to be part of what museums present to audiences.

This is quite different from thinking that science centers should merely show the universal principles of nature. Science centers should also teach something about how we accept the universal truths of science. Perhaps we should rename our demonstrators "natural philosophers."

Richard Toon is senior policy analyst at the Morrison Institute for Public Policy, Arizona State University, Tempe. He was formerly director of education and research at the Arizona Science Center, Phoenix.

Editor's Note: For another modern take on a historical demonstration, see Ian Russell's abridged, annotated, and illustrated version of Michael Faraday's 1860 Christmas lectures, "The Chemical History of a Candle," at www.interactives.co.uk/candle.htm.

(Bakken, continued from page 7)

as singular in its effect on today's audiences as it was in the 1700s. There is no better way to recapture the same sense of the mystery and pure fun of science that Franklin and his colleagues experienced 2½ centuries ago. Of course, it also is an effective way to demonstrate the principle of an electrical circuit (and no doubt more memorable than the usual batteries-and-bulbs approach), but the ultimate take-home message for museum visitors is less didactic than emotional.

Joseph Priestley said it well: "The curiosity and surprize [sic] of young persons should be excited as soon as possible; nor should it be much regarded whether they properly understand what they see, or not.... We are, at all ages, but too much in haste to understand...the appearances that present themselves to us."[2] Whenever and wherever the circle shock is performed in The Bakken, it is easy to locate by the boisterous shouts of young and old that echo through the museum. There is nothing like a jolt of static electricity to stimulate curiosity and surprise!

David J. Rhees is executive director of the Bakken Museum, Minneapolis, Minnesota; www.thebakken.org.

2. Priestley, Joseph. *Experiments and Observations* (179-86), London: J. Johnson, 1774–77.

People Presence:

Why Live Demonstration Matters

By Dante Centuori

"You can dream, create, design, and build the most wonderful place in the world...but it requires people to make the dream a reality."—Walt Disney

The author uses a leaf blower and a beach ball to bring the Bernouilli principle to life for a school outreach program. *Photo by Gary Yasaki*

A few years ago, while working at Walt Disney World's Epcot, I attended a meeting for people involved with the Innoventions pavilion. This is an area sponsored by different sci/tech companies that showcases the latest gadgets and technologies. Innoventions is heavily staffed and draws on many departments. Our meeting involved people from operations, entertainment, corporate administration, "Imagineering" (the creative group), and my group, Epcot Science.

The conversation turned to challenges with the floor team; staff were "clumping" and not engaging guests proactively. An Imagineering team leader turned to me and asked, "Dante, how do science centers solve this problem?" Even Disney, with all its resources, it seemed, had not figured out the magic formula for keeping staff consistently engaged with visitors.

What this story really communicates is the importance of live presenters. Disney had invested tens of millions of dollars in Innoventions, but they still saw that a human presence in the pavilion was a key part of the guest experience—so much so that they thought it worth spending time on improving the team, rather than tossing the presenters aside in favor of more animatronic robots.

As technology forges ahead, it is easy to react with more technology to present the science in our institutions. What could be ignored is people's need to come face-to-face with the real world and experience its wonders and phenomena firsthand. Regardless of age, school system, or geography, audiences are still utterly amazed to see Rice Krispies rising up and sticking to a balloon rubbed on someone's head! We should not take for granted how incredibly fascinating "low tech" science phenomena can be.

The power of narrative

Here's what we know. The live experiences we offer in our museums and science centers are among our biggest assets. They are a key part of what visitors want. Several years ago, COSI Toledo started a tobacco education program that featured a 3-D laser show produced by Liberty Science Center. Visitor studies showed it to be effective, but also indicated that people thought the addition of a live presence could improve it. When the show was adapted for COSI's 3-D theater, a discussion component with a facilitator was added for the program. This component was well received and proved to have a positive impact on students' attitudes toward smoking.

Before the Great Lakes Science Center (GLSC) adopted its current business plan, considerable research was done, much of it on audiences. Despite recent trends toward more consumption of personal technology, live science demonstrations turned out to be the number-two ranked experience of interest to visitors, right after traveling exhibitions. Guests also wanted "to feel invited to the center" and "to participate in science-based enrichment." The strongest way to fulfill perceived needs like these is with people.

That finding has since been incorporated in GLSC's strategic focus, as we grow and improve our base of public and school demonstrations and programs. The key to making the wonders of science come alive still rests with the people who bring concepts to life.

Science centers are filled with hundreds of fascinating stories. These can be as simple as pulling a tablecloth out from under a place setting of china to demonstrate the principle of inertia or as complex as taking infrared temperature readings to show the interconnectedness of lake, sky, and land. As Dennis Barrie, whose projects include the International Spy Museum in Washington, D.C., and Cleveland's Rock and Roll Hall of Fame, likes to say, "Narrative is the strength of any exhibition or education."

To unlock the stories, it takes storytellers—maybe not in the formal sense of the art form, but in the more natural sense of a human tradition that goes back millennia. In a science show, there are characters, there is drama, there is build-up, and there is denouement (or catastrophe!). It's all there, and in the hands of a skilled presenter it becomes an engaging window into science and nature for our visitors.

A passion for storytelling

So how do you find a great presenter? It's not impossible, but it does take effort.

Passion and personality come first. Most science centers have the resources for content training, and often you will find a great performer who has some solid science background. Not everyone needs to have prior training in science or education, but it is essential that all have a drive to share some part of the story through science, education, or learning. Passion brings a sincerity and enthusiasm that training cannot.

Personality and stage presence are equally important. Candidates invited to "audition" should be required to bring a prepared 5-minute presentation. There's a lot to learn from this besides presentation skills: You can see if a candidate is well organized, and if he or she has any special talents. Did this one do background research on your institution? Did that one stay within the time limit? Is this candidate able to think and react quickly?

Here's a technique to try: Do a group interview with several candidates and observe how they interact with other potential team members. Can they play off each other? Does someone dominate? How is the chemistry? At Epcot, half-day workshops were used to audition 10 facilitators at a time. GLSC has initiated all-day charrettes of prospective education team members. (Scott Mair, of CRD Parks in Victoria, British Columbia, helped us set up this system.) This is a great way to learn if candidates have the stamina to be "on stage" for a seven-hour shift.

All of this sounds like a huge investment, but it's an investment that will pay off—with fewer mistakes in hiring and, thanks to a corresponding drop in turnover, fewer resources expended in the end. To apply a technology metaphor, a machine is only as good as its operating system. If our exhibits are the "hardware" for the science center experience, then the floor staff and presenters are the essential "software."

Of course, new technologies used well do help to enhance the live presence. Distance learning brings many concepts and experiences to new audiences. Media and video tools help us share intimate live phenomena with larger audiences. And clever uses of stage effects and lighting enliven the experience of a science show.

With developing technology touting "connectivity" and "communication," it may be tempting to focus limited institutional resources on more "stuff." But in the end, it is the excitement that comes from making a personal connection that will continue to drive our industry. And the ultimate argument comes from the visitors themselves—their desire to be invited, to participate, to learn something new and amazing about science. There are so many stories to share. We must provide the storytellers to share them. ■

Dante Centuori is director of education and outreach at the Great Lakes Science Center, Cleveland, Ohio; www.GreatScience.com.

Valued by Visitors

In late 2005, the Museum of Science and Industry, Chicago, completed a summative evaluation of the perceived value and success of current floor demonstrations and their impact on the guest experience.

Overall, the consensus was that our guests enjoyed the interaction between the demonstrator and the audience and believed that demonstrations added value to their museum visit. When asked if they thought demonstrations should be part of the daily museum experience, 63 percent of visitors surveyed indicated they would like to see more live demos offered. This led to an institutional decision to increase the level of facilitated experiences, including science demonstrations, live theater, and other interpretive programming.

In 2006, we added a chemistry show, *Bangs, Flashes & Fire*, to our repertoire as a pilot for larger demonstration programs. Introducing fire and concentrated acid on the main floor of the museum took persistence, months of planning, and weeks of behind-the-scenes practice for the education staff. We finally prototyped an installment of this show over the end-of-year holidays and gathered guest feedback.

Preliminary analysis of the data shows that 90 percent of respondents indicated they enjoyed the demonstration, and 75 percent felt that *Bangs, Flashes & Fire* "added a lot" to the overall value of their visit. Commented one visitor, "I love the opportunity for interactive learning where spontaneous questions may be answered, not just pre-programmed model."

The most popular part of the show was the chemistry standard Elephant's Toothpaste, followed by explosions and fire. A least-liked aspect, we were surprised to find, was that the demonstration was "too short." (We had been assuming that 15–20 minutes was long enough to ask guests to stand around.) Especially heartening was that 82 percent of survey participants mentioned they had discovered something new—ranging from basic science principles (e.g., you need oxygen, fuel, and a spark to make fire) to general life lessons (e.g., don't light a match while pumping gas).

These findings will be incorporated into future program development as we work to provide an increased level of facilitation to engage our guests.—*Dawnne LePretre, Manager of Visitor Programs, Museum of Science and Industry, Chicago*

The Impact of Science Shows: *A Research Study*

By Wendy Sadler

I gave my first science demonstration in 1999, when I was hired to work in public programs at Techniquest, in Cardiff, Wales. I soon became convinced that science shows were a vital part of the public engagement landscape. I could see it in the eyes of my audiences. "Eureka!" moments were occurring right there before me in Techniquest's science theater.

At the same time, I saw that science shows did not have the same status within the museum that exhibitions, with their much larger budgets, enjoyed. At science center conferences, far fewer sessions were dedicated to program-related topics, such as script development, evaluation, presenter training, and props construction, than to issues in exhibit development and marketing. And the evidence surrounding science shows and their impact, I learned, was fairly thin.

For all those reasons, when I entered a master's degree program in "Science and the Public" at the U.K.'s Open University in 2001, I was determined to put some evidence behind my gut feeling. As part of my MSc, I undertook a project to examine the short- and long-term impact of a specific science show, "Music to Your Ears."

The study method

"Music to Your Ears" (MTYE) is a show that I wrote on behalf of the Institute of Physics in 2001 for a schools lecture tour. The show was aimed at 11- to 14-year-olds; the topic was sound, music, and music technology; and the presentation lasted around 60 minutes.

The project included assessing the immediate impact of the pilot performance, as well as some later performances in the tour. During the pilot, held at Techniquest, we also collected contact details from the audience, students at an all-girls school in Cardiff. This would allow me, more than two years later, to interview several individuals in depth about what they remembered from the show.

As an adjunct to analysis of audience responses, and to balance my own personal involvement with the project as writer, performer, and evaluator, I interviewed a number of leading U.K. science presenters to learn their thoughts on the types of demonstrations they use in shows and why they use them.

The questions I hoped to address in my interactions with both groups were these:

- How does short-term impact compare to long-term impact?
- Can we assume that what people say straight after the show will relate to what happens in the longer term?
- How much of the show do people remember after some time has passed?
- Are there different categories of demonstrations, and are some more effective for impact than others?
- Do presenters think in terms of different types of demonstrations when they develop or present their shows? If so, do these different types achieve different objectives with the audience?

Assessing short-term impact

Short-term impact assessment of MTYE was based on the questionnaire that had been distributed to every member of the audience after the pilot show and to selected audiences later in the tour. There were a total of 141 responses, half from 11-year-olds and half from 14-year-olds.

The questionnaire asked students to rate the show for entertainment and educational value and to give some specifics, such as "favorite" and "least favorite" parts. It also asked them to write down "one new thing you have learned" from the show. (This doesn't always equate to the favorite thing but is useful for educational objectives.)

Analysis of these short-term results showed that

- initial reaction to the show overall was 100 percent positive, with rating of "Excellent" or "Good" by all who completed the questionnaire.
- both age groups rated the show as slightly higher on an "entertaining" scale than on an "educational" scale.
- older students tended to rate the science show as slightly less entertaining than did younger ones.

Assessing long-term impact

Before beginning the long-term portion of the "Music to Your Ears" study, I analyzed the short-term comments and drew up categories of demonstrations used in MYTE. I arrived at five categories in all:

- *Curiosity* (C): something weird, a piece of equipment never seen before, something counterintuitive that surprises the audience. MTYE example: use of a theremin, a musical instrument "played" by moving your hands near two aerials.
- *Human* (H): use of a volunteer or all audience members in an interaction, something personal learned, something funny. MTYE example: Audience puts their hands on their throats to feel the vibrations of a sound.
- *Analogy* (A): a visual representation of something usually invisible, using body language to draw a mental picture, employing models to enhance understanding. MTYE example: Using a slinky spring to distinguish between

transverse and longitudinal waves.
• *Mechanics* (M): how things work, taking things apart to see what is inside, how to make simple things, real-life context of the science. MTYE example: pushing a needle through the bottom of a bucket and resting it in a record groove as a low-tech way of making an analog sound recording.
• *Phenomena* (P): direct experience of scientific phenomena, may use equipment not readily available, illustrates basic science with action not words. MTYE example: generating standing waves on a string with a vibration unit and signal generator.

Where a demonstration fell into more than one category, I listed it according to the main reason I had put it into the show at a specific stage. (This introduced a subjective element that had to be taken into account later when assessing results.).

The long-term evaluation was conducted with two smaller focus groups (a total of eight females, all of high socioeconomic status) from the original Cardiff girls school audience. Held about two years after the original performance, these groups took the form of a semi-structured interview. The interviews were recorded and transcribed, and I analysed the results to see how much audience members had remembered and how often they referred to the categories I'd identified.

Without any prompting, interviewees could recall around 20 percent of the demonstrations used in the show. After some further prompts using images and props, they could recall about 50 percent. In addition, around 9 percent of these memories related to content of the show that they had since encountered in other contexts.

From both the questionnaires and the interviews, I was able to draw some further conclusions about the types of demonstration used in MYTE:

• Curiosity demos seem to be universally popular, regardless of audience, and have a high impact rate for short- and long-term recall.

• Human demos are also highly memorable (though not quite as much as Curiosity) and thus have a fairly high impact.

• Mechanics demos are more popular with audiences that are already interested in science. These demos are the ones most likely to help people relate the show to other contexts.

• Analogy and Phenomena demos are useful educational tools, but tend to have less short- and long-term impact.

The data also suggest a correlation between short-term impact and long-term memory. Where resources for longitudinal studies are in short supply, it may be possible to extrapolate from short-term impact to hypothesize about the kind of things likely to be remembered over a longer period of time.

Conclusions

In 10 years of actively writing and presenting shows, I had never before

Animal Archive: A BIG Collaboration

By David Price

In 2001, a team of British Interactive Group (BIG) members—including this author, then new to the field—collaborated to produce "Animal Archive," a science show "resource pack." This effort followed a couple of earlier BIG projects, in which collaborators had pooled their talents to create an explainer exchange program and a science show script on numeracy.

Our team decided to develop a broad resource rather than a single show, believing this would give performers a wider choice of content and presentation style. Because science shows on biology, habitats, and ecosystems are rarely seen, we chose as our topic the animal kingdom. The finished resource, which was created with primary schoolchildren and mixed family audiences in mind, contains six main activities:

• Vital for Life compares the basic requirements for animal life to those of humans.
• What's That? introduces classification: What is it? How does it work? Why bother?
• Animal Magic explores adaptation, comparing animal specialists with the supreme generalist (us).
• Call My Bluff is a true-or-false game about what animals can or cannot do.
• Animal Olympics examines the excellence of animal performance in specific tasks compared with humans.
• Who Am I? breaks down animal characteristics into questions that eliminate all possibilities but one.

Presenter Stephen Howe facilitates "Monsters or Make Believe?," a show that draws heavily on BIG's Animal Archive. *Photo courtesy the Museum of Science and Industry in Manchester*

The activities are supported with advice on how to combine them, as well as complementary demonstration ideas, facts and figures about the animal kingdom, and copyright-free images.

Science communicators from all over the United Kingdom offered to help with "Animal Archive." This diversity gave our collaboration great potential. The challenge was to turn all these fields of expertise and levels of experience into a quality product.

Though we used e-mail extensively during the project, we still needed regular meetings to hold the project to its critical path. It was only there that members could showcase their work to date and brainstorm around any problems. The Science Museum, London, generously provided a meeting place, and our various employers were supportive with time off and travel allowances.

The project took around six months to complete. In July 2002, our working group reconvened at The BIG Event and performed, to the general acclaim of our peers, the sections of the archive we had worked on. Dissemination of "Animal Archive" for a modest fee continues via BIG's e-forum, chat, and web site (*www.big.uk.com*) .

One real strength of the project was the bringing together of so many minds. But equally important were the networking and the support offered by the community. Such factors should be counted in the overall benefits of collaborating on science shows.

David Price is a presenter at the United Kingdom's Museum of Science and Industry in Manchester, and Northwest England regional officer for BIG.

Priority orders of categories established from different elements of study

Questionnaires *(Initial impact)*	**Focus Groups** *(Long-term memory)*	**Professional presenters** *(Presenter perspective)*
1. Curiosity (33%))	1. Curiosity (25%)	1. Curiosity (50%)
2. Human (25%)	2. Mechanics (18%)	2. Human (25%)
=3. Analogy (17%)	3. Human (14%)	=3. Analogy (12.5%)
=3. Mechanics (17%)	4. Phenomena (11%)	=3. Phenomena (12.5%)
5. Phenomena (8%)	5. Analogy (6%)	5. Mechanics (0%)

had time to review what was being done beyond a "snapshot" of evaluation immediately after the show. I was surprised by some of the results (e.g., that "phenomena" demos have fairly low impact), and other data affirmed my instincts about what works particularly well.

I was excited to find a high level of recall after a relatively long period of time, a result that confirmed my reading of doctoral research done by Terry Burns of Australia's University of Newcastle ("Science Shows: Evaluating and Maximising Their Effectiveness for Science Communication," 2003), indicating that museum visitors do recall demonstrations for some time after a show is over.

It was equally exciting to hear that students had made links between things they saw in the show and science in other contexts. If, as this research suggests, even one or two things remain with an audience member long enough for that person to process the memory and use it in an applied situation, this is a genuine achievement for informal science learning and science shows in particular.

The research with presenters holds other implications for our field. Both in my interviews and in previous experience, I have found that presenters tend to rely heavily on "Curiosity" demonstrations. This may lead to the highest possible impact, but does it come at the cost of other demonstration types that actually aid learning?

This goes back to my question about the objectives of the science show. Is it purely a motivational tool for science, or do we want our audiences to learn something concrete about phenomena and facts?

Wendy Sadler (wendy@sciencemadesimple.co.uk) is director of Science Made Simple, Cardiff, Wales, U.K. Details of her "Music to Your Ears" study can be found in the "Research" section at www.sciencemadesimple.co.uk. *The author invites readers interested in discussing their own shows and alternative ways of categorizing science show tools to contact her directly.*

Presenter's Practicum: A Science Shows Workshop

By Walter Ginckels and Harri Montonen

In late October 2006, a two-day workshop for presenters was held at Technopolis, the Flemish Science Centre, Mechelen, Belgium. Wendy Sadler, director of Science Made Simple, Cardiff, U.K., led the sessions, in which "Edutainers" from Technopolis joined with "Explainers" from Finland's Heureka Science Centre to explore the dos and don'ts of successful science shows.

We began by considering such questions as *Why do we perform science shows? How should one begin and end a science show? What is the importance of interaction with the public?* and *How can you get your public participating in an experiment?*

The real heart of the workshop, however, was the practical exercises. At the beginning, each of us was asked to introduce himself or herself in an original way, making sure to use all aspects of a good show—a clear beginning, clear body language (inviting, expressive, enthusiastic), voice skills (articulation, intonation), humor, and a clear ending. We also saw "Long May You Live," a program regularly presented to Technopolis visitors. All sessions were taped for discussion by the group, giving us a chance to analyze our mistakes and learn from our colleagues' approaches.

The most instructive experience of the training may have been the assignment for groups of four to prepare a 30-minute mini show containing three fixed experiments: the Drinking Straw (a straw cut in a V-shape at one end is used as a musical instrument); the Balloon Kebab (a sharpened skewer is run though an inflated balloon without popping it); and the Howling Tube (a ribbed tube is spun around to produce a loud sound).

It was amazing to see how different the same three experiments could be. In the hands of one presenter, the Howling Tube was a musical instrument; another employed it to empty a plastic bag; and a third used it to spread confetti all around. Two groups combined their efforts to produce a science spectacular, complete with story line to tie the show together.

At the end of the workshop, each presenter was again invited to perform individually, this time by demonstrating her or his "favorite experiment." Things were burning, flying, and exploding. The "tonic water fountain" experiment , an adaption of the Diet Coke and Mentos demonstration made famous on the Internet, was developed, with the aid of a UV light, into a "glowing tonic water fountain" 2 meters in height. It was hilarious to see our fellow professionals enjoying themselves and going to extremes.

One of the Heureka attendees summed up the experience beautifully: "The most important thing in this session for me was realizing that even though in Finland we are [isolated], we are not alone as science show persons in the world."

Walter Ginckels is supervisor of Edutainers at Technopolis, the Flemish Science Centre, Mechelen, Belgium, and Harri "Heko" Montonen is senior Explainer at Heureka, The Finnish Science Centre, Vantaa, Finland.

Attendees at the Science Show Workshop at Technopolis. *Photo courtesy Science Made Simple*

Staging Science: *The Case for Theater in Museums*

By Catherine Hughes

The last decade has seen a significant increase in the number of theatrical productions inspired by science and scientific endeavors. Mainstream dramas like Michael Frayn's *Copenhagen* (1998) and Peter Parnell's *QED* (2001) play around the world to great acclaim. Innovative nonprofit initiatives like the Ensemble Studio Theatre/Alfred P. Sloan Foundation Science & Technology Project in New York City bring artists together to explore the worlds of science and technology in challenging works like Arthur Giron's *Moving Bodies* (2000) and Cassandra Medley's *Relativity* (2006).

Universities are getting involved. MIT recently joined with Boston's Underground Railway Theater in the "Catalyst Collaborative at MIT," a project that will develop new plays about science. And numerous science theater companies have sprung up in the United Kingdom, United States, Canada, and Australia.

This may seem an odd new trend, but it is not. Science has inspired play writing since Aristotle. The relationship is naturally symbiotic: Science needs theater to deconstruct and humanize it, while theater needs the kind of relevant and life-affecting material that science can provide.

What makes current science theater different from past efforts like Bertolt Brecht's *Life of Galileo* (1943) or Friedrich Durenmatt's *The Physicists* (1962) is the attempt—in many cases successful—to tackle head-on, with consummate theatrical technique, truly difficult scientific content. Productions today deal with topics that have high policy value, from DNA sequencing and cloning to genetically modified food and global warming.

The rise of theater in science centers

Science centers and museums have their own history with science drama. In the 1970s and especially the 1980s, museums in many parts of the world realized that in order to engage more visitors in science or the objects and principles of science, they would need to utilize a new set of tools—theatrical tools—that would include characters, music, lights, sound, narrative, and emotion.

Productions today deal with topics that have high policy value, from DNA sequencing and cloning to genetically modified food and global warming.

Science theater in a museum can happen on stages or in exhibitions or gallery halls, can be set or improvised, and is usually under 30 minutes in length. Though generally performed indoors, museum theater has much in common with street theater. The museum visitor has much to capture his or her attention, and theater is only one offering. The actors must "busk" their performance to a non-theater-going crowd, who often hold assumptions about what a theater performance is. This is truly bringing theater back to the general public, who might never make the choice to step inside the hallowed halls of a playhouse.

In the United States, the Science Museum of Minnesota, St. Paul, was a pioneer of museum theater. My own former institution, the Museum of Science, Boston, was also in the vanguard and continues to create innovative theater programming. In 1993, I was involved in a play there that dealt with the social and ethical implications of the Human Genome Project. This play, Jon Lipsky's *Mapping the Soul*, asked questions like "What is normal in a human being? Who is going to decide what is normal?"

When it was first performed, an evaluation revealed that the majority of visitors had never heard of the Human Genome Project, and therefore had never contemplated these questions. A later study of high school student responses to this play[1] suggested that students found the production useful for learning. One student had this comment: "The actors ... use regular, everyday situations and they talk casually. It's not like in presentations, where you have to spew out a bunch of information that people don't even understand. I guess that is what makes an audience kind of bored. But in a play, that brings them in."

Theater and the brain

I left Boston in 2002 to pursue a doctorate in education at the Ohio State University. The central question of my research is "What are the relationships between emotional content and factual content in museum theater performance in terms of audience reception?"

1. Black, D. and A. Goldowsky. "Science Theater as an Interpretive Technique in a Science Museum." Presented at the meeting of the National Association of Research in Science Teaching, Boston, Mass.: March 1999.

In preliminary analysis of my dissertation research, I am finding that visitors remember a science theater performance through narrative cues. In particular, they begin by establishing the characters, which moves them to remember further specifics. However, the most detailed accounts (provided in telephone interviews three to four months after a museum visit) have been those that include an emotional aspect, about either the style or content of a performance. People mention their surprise, awe, involvement, stimulation, or amazement. They are impressed with the theatrical form, though many declare themselves non-theater-goers.

One visitor who had seen a play about the *Titanic* and other technological disasters described how the theatrical form assisted her understanding and lent an emotional quality: "I liked the one person. She was acting as the captain.... I remember when they were trying to get on the lifeboats. I remember her face and her body. It was kind of neat the way she could give you a feeling about it—better than being read a story...."

There is a process of translation that occurs when theater approaches science that allows the public to gain a foothold. This might be an emotional connection, a narrative structure, cultural references, visual images, or a song. Such footholds provide access for a variety of learners, or, to put it in terms that educational psychologist Howard Gardner might use, people can learn from theater kinesthetically, linguistically, interpersonally, intrapersonally, and spiritually. Additionally, as part of the age-old oral tradition of passing on knowledge, theater is particularly helpful to nonreaders.

Research supports and can inform the connection between theater and science. The fields of neuroscience and psychology have found ample evidence that people are more likely to remember emotional information than information lacking in emotional import. This is part of our physiology.

When humans have an emotional reaction to a stimulus, our amygdala,

Theater at the New York Hall of Science

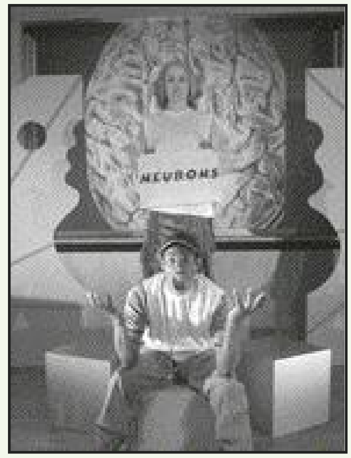
By Marcos Stafne

The mission of the New York Hall of Science is "to convey the excitement and understanding of science and technology to children, families, teachers, and others by galvanizing their curiosity and offering them creative, participatory ways to learn."

When the museum's Science Theatre program was being developed, starting in 2000, careful consideration was taken to ensure that the program's mission followed these guidelines. All theater pieces at the Hall of Science must raise "curiosity" by instilling inquiry in the visitors who choose to watch the show. The plays must foster "creative, participatory ways to learn," offering a number of interactive demonstrations in which members of the audience come on to the stage.

Because the Hall of Science already employed educators, called "Explainers," who could handle any follow up questions that audience members would have, the decision was made to hire professional actors who work well with children. These actors do not create a fourth wall to their stage; instead they always cast the audience in a role, such as lab interns or members of a secret mission. This allows the actors to talk actively to the audience, and the audience to feel that they are a part of an adventure.

Science Theatre at the New York Hall of Science has had a rich production history. Scripts are often written in-house by museum staff. The philosophy is that science encompasses many things. In shows like *Dr. Frankenstein's Lighting and Electricity Show* and *Dr. Fran Kenstein's Scary Sound Show*, the museum takes cultural idioms with negative connotations and turns them into positive vehicles to explore science. The program has reached out to girls and women with shows like *Prehistorock: A Dinosaur Musical*, featuring a young female paleontologist, and *Spaced Out Science*, featuring a young woman who aspires to be an astronaut. Presentations exploring the history of women in science have included *Science Snapshots: Female*



Actors Clarke Mims (top) and Matthew Morgan appear as Reason and Imagination in *Brain Cabaret*, a two-person comedy show at the New York Hall of Science. *Photo by Marcos Stafne*

Scientists, in which one woman portrays five famous scientists, and *Marie Curie's Laboratory*, about the history and accomplishments of the Nobel Prize winner, discoverer of radium.

Puppet shows are also included in Science Theatre stock. Performed in the museum's Preschool Place, these deal with subjects pertaining to the natural world and how it coexists with the built world. Craft and puppet making activities follow each of the puppet performances.

Science Theatre at the Hall of Science is not without challenges, of course. One is the limited resources the museum has for production in a city that has the highest production values in the world. Another is the need for sensitivity to the requirements of a diverse cultural community. Demonstration parts of the show must be highly visual and active so they can reach even those visitors who may not understand the wording of the text. ■

Marcos Stafne is director of public programs at the New York Hall of Science, Queens. This article is adapted from his 2005 thesis for the M.A. program in theater at Hunter College, City University of New York. For the full report, contact him at mstafne@nyscience.org.

the emotional center of the brain, is stimulated. Recent work on memory[2,3] suggests that the amygdala enhances long-term memory formation through modulation of hippocampal activity and that it does this in response to emotionally arousing stimuli but not to emotionally neutral stimuli.

In addition, the work of neuroscientist Antonio Damasio[4] indicates that emotions are essential to humans' full range of cognitive abilities. This is the reversal of the common wisdom that in order to think we need to rid ourselves of emotion. Good theater is emotional, and it stands to reason that presenting complex science information through museum theater, which combines the emotional with the cognitive, will enable the fullest understanding of this material. The message for science centers seems commonsensical, but is here powered by scientific research: Let's get emotional about science!

I am hopeful for and wish to encourage an increase in collaborations between mainstream theater efforts and those in science museums, which will only strengthen the impact and power of science theater. It is vital that theater's contribution to the public understanding of science be recognized. ■

*Catherine Hughes (hughes.929@osu.edu) is finishing her Ph.D. in education at the School of Teaching and Learning at the Ohio State University. She is an honorary board member of IMTAL, the International Museum Theatre Alliance (*www.imtal.org*), a network for those practicing theater in museums.*

2. Hamann, S., T. Ely, S. Grafton, and C. Kilts. "Amydala activity related to enhanced memory for pleasant and aversive stimuli." In *Nature Neuroscience,* Vol. 2, No. 3 (1999).
3. McGaugh, J.L., L. Cahill, and B. Roozendaal. "Involvement of the Amygdala in Memory Storage: Interaction with Other Brain Systems." Presented at colloquium "Memory: Recording Experience in Cells and Circuits," February 17–20, 1996.
4. Damasio, Antonio. *Descartes' Error: Emotion, Reason, and the Human Brain.* New York: Avon, 1994.

Calendar

MARCH

8–18 **National Science & Engineering Week (U.K.).** Coordinated by the BA. ***Details:*** www.the-ba.net/nsew

9–11 **ASTC RAP Session.*** "The Ultimate Science Show Discussion." Hosted by Heureka, the Finnish Science Centre, Vantaa, Finland. ***Details:*** Lea Tuuli, lea.tuuli@heureka.fi

12–18 **Brain Awareness Week.** An international effort organized by the Dana Alliance for Brain Initiatives to advance public awareness about the progress and benefits of brain research. ***Details:*** www.dana.org/brainweek

APRIL

1–30 **Mathematics Awareness Month.** ***Details:*** www.mathaware.org

11–14 **Museums & the Web 2007.** San Francisco, California. ***Details:*** www.archimuse.com/mw2007

MAY

10–12 **Interactivity 2007.** "Embracing Diversity in Your Town Square." Association of Children's Museums annual meeting. ***Details:*** www.childrensmuseums.org

13–17 **American Association of Museums Annual Meeting.** Chicago, Illinois. ***Details:*** www.aam-us.org

18 **International Museum Day.** Sponsored by the International Council of Museums (ICOM). ***Details:*** www.icom.org/imd.html

22–23 **ASTC RAP Session.*** "Creating Quality Connections between Museums and Schools." Hosted by Creative Discovery Museum, Chattanooga, Tennessee. ***Details:*** Lynn Mulligan, 423/648-6068, lpm@cdmfun.org

31–June 2 **Ecsite Annual Conference.** Lisbon, Portugal. ***Details:*** www.ecsite.net

JUNE

7–9 **CASC Annual Conference.** Hosted by TELUS World of Science–Edmonton, Alberta. ***Details:*** www.canadiansciencecentres.ca/conferences.htm

8 **World Ocean Day.** Sponsored by the World Ocean Network and The Ocean Project. ***Details:*** www.worldoceannetwork.org

17–21 **Visitor Studies Association Conference.** "Evaluation and Diversity: Listening to Many Voices." Ottawa, Ontario, Canada. ***Details:*** www.visitorstudies.com

JULY

25–27 **BIG Event 2007.** The annual gathering of the British Interactive Group. Hosted by Magna Science Adventure Center, Rotherham, South Yorkshire, U.K. ***Details:*** www.big.uk.com

SEPTEMBER

23–25 **Giant Screen Cinema Association Conference.** Vancouver, British Columbia, Canada. ***Details:*** www.giantscreencinema.com

OCTOBER

13–16 **ASTC Annual Conference.** Hosted by the California Science Center, Los Angeles. ***Details:*** www.astc.org/conference

** For information on ASTC RAPs, visit* www.astc.org/profdev/. *For updated events listings, click on 'Calendar' at* www.astc.org.

New ASTC Sourcebook Published

The *2006 ASTC Sourcebook of Statistics & Analysis* was released in January. The new *Sourcebook* includes more than 60 tables and graphs presenting survey data on attendance and membership, employees and volunteers, and facilities and finances at 205 science centers and museums worldwide—our highest response rate yet. Also featured this year is an analysis of attendance patterns and trends based on five years of aggregated attendance data from a subset of U.S. members.

The cost of the publication is $40 for members; $50 for nonmembers. Copies of the 2005 *Sourcebook* are still available at the same prices. To order, call 202/783-7200 x140, or write to pubs@astc.org.

NISE Net Begins Second Year

The Nanoscale Informal Science Education Network (NISE Net) held its second annual meeting in San Francisco November 15–17, 2006, hosted by the Exploratorium. The five-year, NSF-funded project has three desired impacts for public audiences: increased awareness of nanoscale science, engineering, and technology, including their potential benefits and impacts on our lives; increased understanding of the structure of matter and the forces at work at the nanoscale; and increased understanding among adult audiences of the societal issues involved in the development of new technologies and the role public dialogue can play in this process.

The first year of NISE Net resulted in a broad range of collaborations linking the three main institutions—the Museum of Science, Boston; the Science Museum of Minnesota (SMM); and the Exploratorium—with 10 organizational partners and more than 75 scientists and engineers. Projects under development include

- a visualization lab to explore the challenge of communicating qualities of the nanoscale;
- a network media infrastructure for production and dissemination of A/V media to engage the public in nanoscale science and engineering in exhibits, public spaces, and on the Web;
- forums for dialogue and deliberation on nanotechnology and its societal and environmental implications for adults and teens;
- a public web site to deliver educational nano media and links to broader resources;
- a professional resource center web site to support NISE Net development and sharing of knowledge, products, and programs;
- a suite of exhibits and programs to raise the awareness and engagement of the visiting public in connection with nanoscale science, engineering, and technology;
- concepts for immersive environments, such as 3-D digital cinema, live theater, object theaters, video caves, or planetariums;
- professional development for informal science educators, research center outreach educators, and science and engineering graduate students;
- an annual meeting of network participants and additional members of research and formal and informal education organizations to share knowledge and build community;
- research and evaluation to guide development and dissemination of best practices in nanoscale informal science education; and
- the NISE Net itself, a flexible and sustainable structure for the ongoing development and dissemination of nanoscale informal science education across a broad range of institutions.

Exhibits, programs, media, and public and professional resources will continue to be expanded during year two. Expect to hear more about these collaborations as NISE Net works toward its goal of helping at least 100 venues include nanoscale science and engineering in their educational programs.

To subscribe to the NISE Network newsletter, contact Vrylena Olney at volney@mos.org.

Welcome to ASTC

The following new members were among those approved by ASTC's Membership Committee in October 2006. Contact information is available in the About ASTC section of the ASTC web site, www.astc.org.

SCIENCE CENTER AND MUSEUM MEMBERS

- **Center for Science & Math Education/Museum of Natural Science,** Ogden, Utah. Housed on the campus of Weber State University, this center hosted its 17th Science Olympiad in 2006, with more than 560 students from 41 schools participating.
- **Minnetrista**, Muncie, Indiana. This cultural center's 40-acre campus, located on land formerly belonging to the Ball family (of Ball Brothers canning jar fame), features a nature area, formal gardens, several historic homes, and exhibitions of history and art.
- **Musée de la Nature et des Sciences,** Sherbrooke, Québec, Canada. This 120-year-old museum with a collection of more than 65,000 artifacts not only welcomes visitors but also serves as a resource for other cultural institutions in Québec.
- **National Maritime Museum of the Gulf of Mexico,** Mobile, Alabama. Projected to open in 2008, this 90,000-square-foot, $30 million facility will both preserve the maritime history, culture, and traditions of the Gulf of Mexico and interpret them through hands-on exhibits, programs, and traveling exhibitions.
- **Science East,** Fredericton, Nova Scotia, Canada. This 10-year-old science center with indoor and outdoor exhibits has the perhaps unique distinction of being housed in a historic former county jail.
- **World of Wonders Science Museum,** Woodbridge, California. The community of Lodi, California, hopes to open its 12,000-square-foot museum, which will feature hands-on exhibits, school programs, and a science store, in 2008.

SUSTAINING MEMBERS

- **Clean Air–Cool Planet,** Portsmouth, New Hampshire
- **Communications Electronic Design,** Louisville, Kentucky
- **Interface Guru,** Tucson, Arizona
- **Universal Services Associates, Inc.,** Colwyn, Pennsylvania
- **Wright Brothers Aeroplane Company,** West Milton, Ohio.

Spotlights

By Carolyn Sutterfield

Visitors can learn about television production and make their own multilayered videos in the U-TV mini studio at COSI Columbus. *Photo courtesy WOSU@COSI*

WOSU@COSI OPENS—On September 29, the only combination science center/public broadcasting site in the United States opened at **COSI Columbus,** in Columbus, Ohio. In May 2005, WOSU Public Media, central Ohio's public television and radio provider, signed an agreement to share COSI's 320,000-square-foot facility, build a state-of-the-art digital media center, and collaborate with the science center in a variety of projects.

The new 12,000-square-foot WOSU@COSI includes multimedia studios and community space for civic engagement, forums, performances, events, and meetings. It also features a media literacy lab and hands-on digital and media and technology activities co-produced by the station and COSI.

Visitors can tour a working television and radio studio, make their own multilayered videos in the U-TV mini-studio, try out special effects on EffecTV, and participate in live community events. The station's first Open Line radio talk show, with a live audience, was broadcast from WOSU@COSI on January 26.

The architecture, engineering, and design firm responsible for the $5.6 million project was Burt Hill. Funding came from a combination of corporate sponsors, private donors, and foundations, as well as a $1.5 million endowment fund.

Details: Kelli Nowinsky, public relations manager, COSI; knowinsky@mail.cosi.org; *www.cosi.org*

MAKEOVER FOR AN ICON—**The Canadian Museum of Nature,** in downtown Ottawa, is celebrating its 150th anniversary with a major renovation and expansion of its castle-like home, the 1912 Victoria Memorial Museum Building. A three-year renovation of the museum's west wing culminated in 2006 with the opening of the new Talisman Energy Fossil Gallery, a new Discovery Zone, the refurbished Mammal Gallery, space for temporary exhibitions, and a new interactive Bird Gallery.

Supported by a $2 million grant from Talisman Energy, as part of the museum's $10 million (Canadian) Natural Partnerships fund-raising campaign, the fossil gallery focuses on the 50-million-year span that includes the end of the dinosaurs and the rise of mammals. Among its 300 specimens are 36 complete skeletons. The 4,300-square-foot Bird Gallery features specimens of every bird found in Canada (more than 500 in all). Touch-screen computers and hands-on exhibits help visitors learn how to distinguish physical characteristics of birds, understand bird behavior, and even care for injured birds. Support for the project came from Wildlife Habitat Canada and the Canadian Wildlife Service.

Opened in October 2006, the Canadian Museum of Nature's Talisman Energy Fossil Gallery is part of a major renovation of the historic Victoria Memorial Museum Building. *Photo by Martin Lipman*

Also completed in 2006 was a south wing addition that houses shipping/receiving, live animal care, exhibit workshops, and facilities maintenance.

To date, the Natural Partnerships campaign has brought in nearly 70 percent of the museum's goal. Still under renovation is the museum's east wing, which closed in November; this phase will be completed in 2009–2010.

Details: *http://nature.ca*

CULTIVATING CURIOSITY—Kids' play already involves manipulating, problem solving, and discovery. Educators at the **Carnegie Science Center,** Pittsburgh, Pennsylvania, have created "Let's Explore," a new training program that helps early childhood teachers and caregivers encourage curiosity and stimulate "scientific thinking" among children aged 1 to 5. Workshop participants learn how to build on children's natural impulses to help them ask questions, explore, experiment, observe, and develop their own theories.

Funded by a grant from the National Science Foundation, "Let's Explore" was developed by the science center's Girls, Math & Science Partnership program, with Family Communications Inc., producers of the "Mister Rogers' Neighborhood" public television series. Materials reflect the style and philosophy of the late Fred Rogers. The three-hour, hands-on workshop, offered on-site or off-site for a one-time fee of $750 (plus travel expenses, where appropriate), can accommodate 15 to 30 participants. Each session includes a training manual, video segments, a presentation guide, handout masters, and an appendix of background materials. Museum professionals who take the training are then free to offer the workshop to educators in their own regions.

Details: Keri Medwid, 412/237-3374, MedwidK@CarnegieScienceCenter.org

TRACKING 'HACKER'—Visitors to the **Children's Museum of Houston** (CMH) in Texas can now join their favorite public television math whizzes, the Cybersquad, as they explore math concepts like place value, fractions, and probability while preventing the villainous Hacker from destroying Cyberspace.

Cyberchase–The Chase Is On!, a traveling exhibition developed by CMH in partnership with Thirteen/WNET New York, picks up on the popular PBS series to encourage children and families to use mathematics to solve mysteries. Exhibits are organized in three areas based on the TV show.

In Control Central, the properties of fractions help visitors reinstall "power circuits" removed by Hacker. In the Grim Wreaker, visitors explore spatial relationships and use principles of probability and the process of elimination to find Hacker and prevent his rocket from launching. In Poddleville, a community of Cyberspace inhabitants, tasks revolve around basic principles of algebra and pattern recognition. Other activities include Trailing Icky, an exercise in navigation skills, and Kahuna-huna Race-A-Runa, where visitors complete a racetrack by correctly placing sections representing decimals.

A visitor to *Cyberchase–The Chase Is On!* finds clues while exploring the differences in an object seen from different angles and in different light.
Photo by Tom DuBrock

The National Science Foundation provided $1.4 million to develop the bilingual (English/Spanish) exhibition, which will tour after closing at CMH in September. Cyberchase is produced by Thirteen/WNET New York and Nelvana Limited.

Details: Shannon Weaver, sweaver@cmhouston.org; *www.cmhouston.org*

RISE OF THE PC—Few know that that Bill Gates and Paul Allen first started their Microsoft company in Albuquerque, New Mexico, in 1975. To honor that history, Paul Allen, now a major U.S. philanthropist, has funded a permanent exhibition at the **New Mexico Museum of Natural History & Science.** STARTUP: *Albuquerque and the Personal Computer Revolution* focuses on the history of the microcomputer and the technological innovations that made it possible.

The 4,000-square-foot gallery, which opened November 18, 2006, includes artifacts from the Smithsonian Institution, the Microsoft corporate archives, the Paul G. Allen collection, and the Computer History Museums. Videos tell the personal stories of Gates and Allen, Robert Noyce (Intel), Ed Roberts (inventor of the Altair), Steve Jobs and Steve Wozniak (Apple Computer), and other IT visionaries. An immersive multimedia theater experience, "Rise of the Machines," traces the evolution of the PC from business machine to pop icon.

Additional funding for STARTUP came from the Bill and Melinda Gates Foundation, Microsoft, and the New Mexico Museum of Natural History Foundation. Exhibits, interactive displays, and the STARTUP web site were developed by Weatherhead Experience Design Group.

Details: Tim Aydelott, NMMNHS, tim.aydelott@state.nm.us; *www.startupgallery.org* ■

Grants & Awards

Liberty Science Center (LSC), Jersey City, New Jersey, has received major funding from two sources. The National Science Foundation awarded the science center $1.8 million for *Science Now, Science Everywhere,* a three-year research project to support a cell-phone-based, extended-learning tool for visitors; partners include the Center for Mobile Communication Studies at Rutgers University and the **Institute for Learning Innovation,** Annapolis, Maryland. In addition, LSC trustee Jennifer A. Chaisty donated $5.1 million toward LSC's new Center for Learning and Teaching. Currently closed for expansion and renewal, the museum will reopen in July.

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Recent private sector grants have put the **Virginia Air & Space Center,** Hampton, over the $2 million mark in the campaign for its new Space Quest gallery and Hunter B. Andrews Education Center. Contributions came from Dominion Power ($100,000), a private Richmond foundation ($100,000), the Verizon Foundation ($18,500), and the Beazley Foundation ($50,000).

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The **California Academy of Sciences,** San Francisco, received $2 million from the Richard and Rhoda Goldman Foundation for its new building in Golden Gate Park, scheduled to open in 2008.

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The 11 institutions that received 2006 Science Education Partnership Awards (SEPA) from the National Center for Research Resources (NCRR) of the National Institutes of Health (NIH) included two ASTC members:

• **The Imaginarium,** Anchorage, Alaska: $1,346,509 for *North Star* (Phases I and II), a five-year project, in partnership with the University of Alaska–Anchorage Department of Biological Sciences, Providence Alaska Hospital, and a statewide advisory committee to provide (1) access to biomedical research mentors for 25 educationally and/or economically disadvantaged Alaskan high school students (predominantly Alaska Natives from rural villages); (2) a six-week summer institute focusing on a pre-med curriculum and job-shadowing opportunities; (3) school-year internships at the Imaginarium for 60 educationally and/or economically disadvantaged Anchorage students in grades 8-12; (4) inquiry-based professional development for 200 teachers across Alaska; (5) a means for university and hospital researchers to disseminate their research methods and results in public venues; and (6) a web site for showcasing student and biomedical research, with a participant forum for blogging.

• **The Miami Museum of Science & Planetarium,** $745,419 as a partner and subcontractor with the University of Miami–Coral Gables, for *Heart Smart,* a five-year, $1.37 million project to create a hands-on traveling exhibition with complementary classroom and Web-based resources aimed at raising student and public awareness about cardiovascular disease risk factors, as well as strategies for reducing these risks and improving personal health. ■

People

At the Academy of Natural Sciences, Philadelphia, exhibit developer **Barbara Ceiga** has been promoted to exhibits director. Ceiga was formerly senior exhibition developer at the Field Museum, Chicago.

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Patrick J. Flynn has joined the Museum of Discovery and Science, Fort Lauderdale, Florida, as executive vice president of development. Flynn was previously managing director of the Florida Grand Opera.

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After 20 years in the science communication field, **Melanie Quin** left her position as executive director of Ecsite-uk, London, on January 12. For the next year, she will teach English as a second language with English First in Istanbul, Turkey.

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The Museum of Science, Boston, has picked **Peter K. Johnson,** formerly director of exhibits and design at the New England Aquarium, to be its vice president for exhibits and design. Also announced by MOS were the following promotions: **Paul Fontaine,** to vice president of programming; **Jonathan Burke,** to vice president of visitor services and operations, **Heather Calvin,** to associate vice president of visitor services and membership; and **Carl Zukroff,** to director of publications and internal marketing.

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The John P. McGovern Museum of Health & Medical Science (The Health Museum), Houston, Texas, has appointed **Phil Lindsey** as vice president for exhibits and business development. Lindsey was most recently an exhibit planner and manager at the Tech Museum of Innovation, San Jose.

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The new planetarium director at the South Florida Science Museum, West Palm Beach, is **Woodrow Grizzle.** Formerly director of education at the Southwest Virginia Museum Historical State Park in Big Stone Gap, Grizzle will also contribute astronomy articles to the museum's publications.

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On November 1, 2006, **Kathy Sullivan,** former CEO of Ohio's COSI Columbus, became the inaugural director of the Battelle Center for Mathematics and Science Education Policy at the Ohio State University's John Glenn School of Public Affairs. Sullivan will continue to volunteer as science advisor to COSI.

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Joyce Gardella has joined the Exploratorium, San Francisco, as marketing director. Gardella, who worked at the Museum of Science, Boston, in the 1990s, most recently served the field as a marketing consultant. She replaces **Rosemary Prawdzik,** who has relocated to Colorado.

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"He built the Museum of Science." That's what explorer, photographer, cartographer, and mountain climber **Bradford Washburn** once told a *Boston Globe* reporter who asked what he wanted in his obituary. The quote appeared in the *Globe,* as requested, after Washburn died on January 10, aged 96. The Massachusetts native took over the New England Museum of Natural History in 1939, at age 29, and raised millions of dollars to transform the ailing institution into the showcase of science that opened alongside the Charles River in 1951. Among his major additions to the museum were its planetarium and signature 2½-million-volt Van de Graaff generator. When ASTC was incorporated in 1973, Washburn was on the board of directors. At 89, he served on a team that used hikers and global positioning technology to determine the true height of Mount Everest—29,035 feet, 7 feet higher than previously thought. ■

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