IMMERSED IN SCIENCE:
Learning in Today’s Digital Environments

Immersive Digital Interactives: An Emerging Medium for Exhibitions
Digital Games as Learning Platforms
From 2-D to 3-D Web: The Science Center in ‘Second Life’
Embedding Virtual Reality in Exhibitions: A Perspective from Paris
Changes in Attitude: Designing for Visitor Expectations
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In July/August 2006, this journal examined new social technologies—blogs, podcasts, wikis, RSS feeds, and other "Web 2.0" communication tools that allow Internet users to personalize their online experiences. That was then; this is now. Moving past MySpace, Facebook, and YouTube, the buzz today is about immersive digital experiences, mixed realities, avatars, and the "3-D Web." Researchers document the benefits of video gaming and design "serious" games to support educational or therapeutic ends. In the multi-user online world Second Life, your custom-designed alter ego can visit a museum, take a class, view a webcast, or interview for a job. Seniors can't get enough of digital brain games, second graders play Zoo Tycoon, and Nintendo's whole-body Wii gaming console flies off the shelves. How does all of this relate to learning in science centers? In this issue, we'll explore the new digital immersive technologies and learn how museums are using them to create experiences for the tech-savvy audiences of the 21st century.

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Cover: Immersive digital experiences, pictured clockwise from top right, include the Cave Automated Virtual Environment at the Singapore Science Centre (courtesy Singapore Science Centre); the interactive exhibit Mariposa by Zack Simpson (@ Mine-Control); Pi Garden exhibits in the Exploratorium's Spoland (image by Second Life resident Feen Cazalet); and Raydon's driver-training simulator at Ortonicon (courtesy Orlando Science Center).

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Immersive Digital Interactives: An Emerging Medium for Exhibitions

By Eric Siegel

For the past 20 years, designers, artists, educators, and scientists have been converging on a new modality of interactive learning and exploration. New technologies now enable interactive experiences that combine the attributes of real-world immersive visualization, video gaming, simulation and modeling, and social learning.

This article will document the introduction, application, benefits, and challenges of the experiences called “immersive digital interactives” (IDIs)—a term coined by this author and Tom Rockwell of the Exploratorium. IDIs may be defined broadly as full-body, gestural, computer-enabled experiences in which visitors interact with projected images through various motion-tracking and image-processing systems. (Such dynamic systems do not represent well in words or photographs, so readers are encouraged to visit the included URLs for details.)

**IDIs’ converging streams**

Perhaps the most obvious antecedent of IDIs is the CAVE (Cave Automatic Virtual Environment) visualization system. First shown at the Siggraph conference in 1992, the CAVE is completely immersive and three-dimensional, with projections on three or four walls, the floor, and the ceiling. The user wears 3-D glasses and interacts with the projections through full-body motion. Because these systems are costly, they have found a home mostly in corporate and academic research labs, although Austria’s Ars Electronica has exhibited some CAVE programs in what it calls the Museum of the Future (www.aec.at/en/center).

In the mid 1990s, the Media Lab at MIT created a Responsive Environments Group (www.media.mit.edu/resenv/) to explore “the development and application of new sensing modalities and enabling technologies that create new forms of interactive experience and expression.” Subsequent Media Lab groups, such as Interactive Cinema and Things That Think, have created many of the theoretical and technical underpinnings behind IDIs.

The evolution of IDIs was also influenced by arcade games, such as virtual car racing or flight simulators, which use modeled landscapes and user-controlled interaction (joysticks, steering wheels, and force feedback) to create competitive challenges. Today, devices like Nintendo’s phenomenally successful Wii enable players to engage a virtual opponent using natural gestures like swinging or punching. IDI games are finding their way into commercial applications as well: e.g., “Virtual Volleyball” at the mall (www.youtube.com/watch?v=4m26rLGW8ow) or disk jockey kits for parties.

Increasingly, contemporary scientific research depends on computer modeling on scales both large (climate modeling) and small (molecular and atomic level manipulation). This “in silico” modeling imbues virtual objects or environments with “physics,” allowing them to interact in increasingly naturalistic and unpredictable ways.

IDIs share this modeling approach to creating exhibits. For example, Crystal, by Zack Simpson of Mine-Control (www.listal.com/video/1282370), shows water molecules bonding into ice crystals based on programmed—and adjustable—parameters that include the temperature of the environment, the likelihood of bonding, and the tendency of bonds to break.

**Benefits of IDIs in museums**

The first large-scale, long-term installation of IDIs in an informal science setting (at least, in this author’s memory) came in 2002 at the Tech Museum of Innovation, in San Jose, California. There, in a space called Imagination Playground, Peggy Monahan collected or commissioned several groundbreaking pieces by Zack Simpson, including Mariposa and Sand (www.mine-control.com/downloads.html).
Since then, IDIs created by a small group of artists and designers have found their way into U.S. venues ranging from New York’s SONY Wonder-Lab to the Pittsburgh Children’s Museum. A traveling exhibition called Too Small to See, featuring two new IDIs by Simpson, recently began its tour at Disney’s Epcot Center in Florida. Temporary IDI installations are featured at art and technology showcases like Ars Electronica, Eyebeam, Siggraph, and ArtInteractive.

Exhibit designers and developers value the way IDIs foster social learning in science centers. Says Peggy Monahan, “I love these kinds of interactivities because of the way they take advantage of our public spaces. You can’t avoid using them with other people, since they’re in the projection too. It encourages all kinds of great interactions with other visitors.”

The social-learning aspect of an IDI varies according to the design, installation, and mode of interaction built in by the original artist. Camille Utterback’s Liquid Time (www.camilleutterback.com/liquidtime.html), for example, works if even one individual is interacting; most installations benefit from multiple participants. In Scott Snibbe’s Boundary Functions (www.snibbe.com/scott/bf/video.html), “the exhibit doesn’t even exist until two people move onto its interactive floor,” says Snibbe. “When they do, a Voronoi diagram is drawn around them and everyone else on the floor, describing a pattern that has thousands of natural analogues—from bubbles to animal settlement patterns to the gravitational influence of stars. ... People’s relationships to each other are just as important as their relationship to the interactive exhibit.”

The full-body interaction of IDIs suggests another benefit: addressing the diverse learning styles of museum visitors. According to an evaluation conducted at SONY Wonder Lab by Jo Ann Secor, IDIs “allowed for a variety of levels of engagement from full body, gross motor/kinesthetic to fine motor skills.” As science centers offer support for all kinds of learners, IDIs can be an important complement to other interactive exhibits.

Computer modeling is a fundamental tool for studying phenomena outside the scales of human perception: too small (atomic and nanoscale science), too large (cosmology or social sciences), too fast (optics and electronics), or too slow (geology and cosmology). But when visitors can gain access to these same phenomena through interactive simulations, the drawbacks of typical “closed” computer simulations, created in media like Flash and Director, are mitigated by the more open-ended physics modeling in IDIs.

Another set of benefits of including IDIs in informal science settings lies more in the practical realm. Because the infrastructure of IDIs consists primarily of a camera, a computer, and a projector, they are both portable and essentially impervious to mechanical breakdown. At the New York Hall of Science, we have created an IDI “pod” that can be shipped via UPS and assembled and installed by one technician in two hours.

Finally, the same infrastructure can be used for several different IDIs. Again, at the Hall of Science we have created a Sound and Light Lab designed to feature a rotating series of IDIs.

...and some challenges

The integration of IDIs into informal science settings also presents challenges, both for the creator and for the institution. Says Simpson, “Many pieces fall short of the goals I have set for myself. Instead I have to settle for a more aesthetic experience, at which point the limitations of the hardware become apparent.”

Jeff Han, a leading interactive designer and technologist, points out that the lack of touch is an experiential “disconnect” that limits the effectiveness of IDIs. Han suggests that the popular image of Tom Cruise in Minority Report, interacting with masses of data by waving his hands, begs the question of just how effective this mode of interaction is.

Another challenge is that there are currently relatively few individuals creating IDIs for the museum community. The tools they have developed are proprietary and specialized to their individual approaches. And because most of them identify themselves as artists rather than exhibit designers, commissioning an IDI as an art piece for a specific didactic purpose can be both complicated and exhilarating. Negotiations will require flexibility, imagination, and goodwill on all sides, and the outcome is less predictable than the usual “work for hire” approach museums use with exhibit design.

Future directions

Several experiments are under way or proposed that will test new directions in IDIs. In a piece being developed for the Hall of Science and Cornell University, Simpson and David Goodsell are designing an interactive and animated “label” that will serve to reinforce the didactic component of the experience.

Scott Snibbe says he is working to turn IDIs into “more structured and narrative experiences. The long-term goal is to create a new medium as engaging as cinema, yet one in which people still remain aware of their bodies and their social relationships with people around them.”

Software for creating IDIs, such as Cycling 74’s Max/MSP/Jitter, is now commercially available, although such generalized tools are not well tuned to specific museum interactives. A collaboration between Ken Perlin of New York University and the Hall of Science proposes to develop a toolkit through which young people could create and test their own IDIs.

Allowing more designers/artists/programmers to participate in this way would necessarily broaden the base of IDI creators and potentially increase the use and range of creative application of this rich and effective exhibition medium.

Eric Siegel is director and chief content officer at the New York Hall of Science, Queens.
Digital Games as Learning Platforms

By Heather Choy

As a graduate student pursuing a master’s in museum studies at John F Kennedy University, Berkeley, California, Heather Choy researched the rise of video games to become one of the most pervasive mediums in U.S. popular culture. She reviewed what scholars have said about the learning opportunities afforded by games and speculated on ways that gaming technology might be adapted for museum audiences. This article is based on her unpublished thesis, Activating Play: Museum Learning in Game Space.

Ask any gamer what makes a good video game, and you will receive a myriad responses: Good games are open-ended, and they offer choices. They have engaging characters. They adjust to a player’s level, providing the right amount of complexity without being overwhelming. They teach skills that aid in real-life decision-making. Good games are fun.

Different genres of video games offer different learning experiences. In role-playing and simulation games, players learn to manage resources while completing a multitude of tasks. Fighting games require players to make quick decisions based on what has transpired in the game thus far. Strategy games call for careful decision making and anticipation of long-term goals. Players of first-person shooter games must keep track of many objects—visible and invisible—while actively moving through the game’s narrative and virtual space. All of these genres feature adaptive environments where players are encouraged to be creative and use their intelligence to make decisions, advance in game play, and acquire new skills.

Games and education theory

Education theorists have long understood that learning takes place more readily through social interaction. Lev Vygotsky, for example, asserted that social interaction and play are crucial parts of cognitive development, especially for young children. By assuming roles within a game and interacting with others, he said, children learn skills that may be transferred outside of the game to use in real life.

The genre of games known as MMORGs (massively multiplayer online role-playing games) supports what Vygotsky called the “zone of proximal development” (ZPD), which he defined as the distance between an individual’s level of development and the levels of comprehension that can be accomplished in collaboration with others. As players assume roles within a game and interact online in real-time with those more advanced than themselves, they learn the kind of transferable skills that Vygotsky described.

Another researcher whose work has implications for gaming is Mihaly Csikszentmihalyi, the University of Chicago professor of psychology who coined the word “flow” for the state of optimal experience in which a person is so absorbed in an activity that he or she loses track of time and engages in complex activities for their own sake. Citing the game of chess as an example, Csikszentmihalyi notes that at the highest levels, the players experience a sense of flow that is not readily apparent to outsiders who do not fully understand the challenges or intrinsic rewards of the activity. He adds that the state of flow depends on challenge and skill and may not be felt by all players involved in a game.

Video games, in which there is little distinction between self and environment or stimulus and response, lend themselves readily to a state of flow that may be equally unapparent to the observer. But because video games adapt more easily to players’ skill levels, making play challenging enough to command attention without being too difficult, they may be even more conducive to flow than chess.

Constructivist theory, as described by George Hein, suggests that the acquisition of knowledge optimally requires active participation of the learner through both hands- and minds-on activities. In video gaming, players of varying skill sets are placed in a context where they can work through abstract problems by actively testing hypotheses in “real world” applications. Because the simulation is neither linear (there is no one path to follow) nor directed (players choose what they want to do), each experience can be tailored to participants’ abilities and interests—a crucial element in game design.

Howard Gardner, professor of education and cognition at Harvard University, has famously identified seven intelligences (musical, spatial, kineshetic, inter- and intra-personal, linguistic, and logical) that contribute to an individual’s (Continued on page 7)


The Singapore Science Centre has always had at least one component in its galleries that showcases the technology of the day. In the early 1990s, we hosted an exhibition that included a virtual hang-gliding experience. Visitors were literally suspended in harness, given a pair of 3-D glasses, and immersed in a virtual environment that allowed them to “glide” through the Grand Canyon. The exhibit was wildly popular.

More recently, one of the present authors, senior scientific officer Sharlene Anthony, conducted a research study on the impact of immersive exhibits in promoting cognitive and affective learning outcomes among students. The study focused on two exhibits at the science center, the Cave Automated Virtual Environment (CAVE) and the Virtual Cell.

The two studies

The CAVE (since replaced by the Reality Centre, a 3-D visualization theater that can handle up to 40 visitors at a time) was a cube, with sides measuring 3 meters (9.5 feet), that could accommodate up to 12 persons for programs of not more than 15 minutes each. Its technology comprised projection systems, stereo glasses, tracking sensors, four screens, stereo emitters, and a super-computer—all assembled in a configuration that immersed visitors in a 3-D virtual environment. The exhibit was available to schools through pre-bookings and to museum visitors at specified show times.

In the CAVE study, Sharlene observed three classes of Primary 5 (Grade 5) pupils—each comprised of 33 to 35 students of mixed gender, from different schools and of different academic abilities. The students experienced a CAVE program on the molecular structure, properties, and phase transformation of water that was jointly developed by the science center and the Institute of High Performance Computing.

Pre- and posttests were administered to gauge the content knowledge gained from the experience. Students also filled out a survey that elicited their views on the learning environment, educational potential, and effectiveness of the exhibit. Results showed that content knowledge increased in all cases, regardless of gender or academic ability. The survey also showed a positive response to the experience by all students.

In the Virtual Cell exhibit, shown at right, a polarized dual-projection system produces the 3-D effect. The experience, developed by the science center with Nanyang Technological University, is a 4-minute immersive journey from the surface of the human skin into a skin cell, proceeding through the nucleus to the chromosomes, and eventually uncoiling the chromosomes to show the basic DNA structure. The looped program runs all day in our Genome Exhibition area.

The Virtual Cell study involved 108 Secondary 2 (Grade 8) students of mixed gender, from two different schools, with different academic abilities. Students experienced the Virtual Cell tour in groups of 10. The results here were also positive, showing an increase in content learning among all participants. Terms used by students to describe their experience included “cool,” “exciting,” “love it,” and “fun”—demonstrating that this exhibit also left a positive impact on participants.

What’s next

More recently, the Singapore Science Centre opened a new infocomm gallery. Known as i-Space, it showcases a number of immersive experiences that have become favorites with our visitors. One example is Odyssey Report, in which visitors can manipulate files, play videos, and view pictures by using hand gestures in front of a big screen—similar to what they saw in the movie Minority Report. Another is the Tilty Table, a circular surface on which is projected an image of Earth. By tilting the table, visitors can “travel” to different places on the globe. And at the Digital Touch Table, people can draw on virtual paper and even ‘pin up’ their artworks on a big plasma screen.

In i-Space, as with the CAVE and Virtual Cell, we have been able to observe visitors interacting with exhibits and gain valuable information on these potential tools for education. Future plans call for creating a virtual i-Space on the Internet, developing a Visualization Lab, and exploring interactive digital media as an educational tool. Our partner will be the Mixed Reality Laboratory at the National University of Singapore.

As Arthur C. Clarke once said, “Any sufficiently advanced technology is indistinguishable from magic.” At the Singapore Science Centre, we have seen the power of technological “magic” to bring a sparkle to our visitors’ eyes. We will continue to develop and offer immersive science experiences to keep that magic alive.

Magical Science: Evaluating the Impact of Immersive Exhibits

By Daniel Tan and Sharlene Anthony
(Continued from page 5) overall understanding of the world.4 His work underscores the need to present learning experiences through a variety of lenses. Video games not only offer an array of problems and environments in which to operate; they also can be played differently each time, allowing players to vary the skills used to solve problems.

Video games reflect ways that the acquisition of literacy is changing to meet the needs of new learners, says literacy specialist James Paul Gee. Formerly a professor in the department of Curriculum and Instruction at the University of Wisconsin–Madison (UWM) and now chair of the Literacy Studies department at Arizona State University, Gee says games are built with many learning principles in mind, each supported by recent cognitive research suggesting that human perception and action are deeply connected.

In his book What Video Games Have to Teach Us About Learning and Literacy,5 Gee identifies 36 learning principles found in well-designed games, from “material intelligence” and “situated meaning” to a “cycle of expertise,” in which players move from early generalizations about a game to developing and applying high-level cognitive skills. All of the principles are learner-centered; individuals must construct their own meanings by actively engaging game play and connecting complex and simple concepts with actions.

Applying gaming principles

What adventures in physical settings once were for their elders, video games have become for today’s tech-savvy generation—the navigable space of choice. Recognizing the trend, schools of education worldwide have established departments of game studies and digital media. Researchers now actively create digital content, often in collaboration with other cultural institutions, to facilitate learning in formal and informal environments.

At MIT, the Education Arcade (see Resources, page 13), an offshoot of the Comparative Media Studies Department, creates frameworks for incorporating advanced math and science content into game play. Members believe that students who have a hard time applying abstract concepts may be able to process information better in a game, where knowledge is a tool, not an end.

In 2004, the Museum of Science, Boston (MOS), hosted Mystery at the Museum, an augmented-reality (AR) game developed by the Education Arcade and the MIT Teacher Education Program that merged physical and virtual museum environments. Families were given location-aware, handheld devices linked to the museum’s wireless network and sent off to find a band of thieves who had stolen a museum artifact, replacing it with a replica. Assuming the roles of biologist, technologist, and detective, participants navigated through the galleries, downloaded virtual objects and interviewed “suspects” to identify the artifact, learn how it was stolen, and catch the thieves before they got away.

The game was a hit with parents and kids alike. In a June 2004 interview in the MIT Technology Review, MOS program manager Sheila Jasalavich said she had “never seen a technology project engage women and girls like this game. A lot of technology leaves girls behind.”

Another Boston-area group of researchers—the department of Technology, Education, and Innovation at the Harvard Graduate School of Education (HGSE)—was among the first to work with “multi-user virtual environment simulator” games (MUVES) as collaborative learning environments. HGSE professor Chris Dede and colleagues, together with George Mason University, the Smithsonian’s National Museum of American History (NMAH), and the Boston Public Schools, developed River City, a 19th-century virtual world populated by players, non-player characters, and other computer-based agents. Featured in the environment were digital images of objects from NMAH collections. Within this historical/social context, players were challenged to battle an outbreak of illness and prevent contamination of the city’s water supply.

The game was piloted in middle schools in Boston and Arlington, Virginia, from 2000 to 2002. Students worked in teams, exchanging ideas and collecting data about the virtual city. They also collected real-world water samples and wrote in lab notebooks, which doubled as instruction manuals.

River City borrowed a number of features from commercial game play, Characters could adopt both first-person and third-person perspectives, look in every direction, and even express emotion—all elements that contribute to a sense of immersion. (Research reports are posted on the project web site; see Resources, page 13.)

The number of university-based programs involved in developing digital content continues to grow. In the United States alone, we find the Games, Learning, and Society group (GLS), an outgrowth of the Educational Communications and Technology Program of UWM’s Curriculum and Instruction department; the Interactive Media Division at the University of Southern California; the Game Culture and Technology Lab at the University of California–Irvine; the Entertainment Technology Program at Carnegie Mellon University; and the Experimental Game Lab at Georgia Tech.

The takeaway message? Narrative-driven immersive experiences, like those found in video games, provide meaningful ways for all types of learners to engage with content. For museums interested in developing such experiences for their audiences, there is no shortage of potential partners. If museum educators and experience designers will take time to play video games, understand video games, and learn how to apply the mechanics of gaming to museum programming, they will find that they have a valuable set of tools for creating the kinds of experiences that resonate with today’s audiences.

Heather Choy received her master’s from JFK University in 2004; she recently accepted a position at the University of California’s Lawrence Hall of Science.

Museums are already using 3-D visualization, animation, and even single-user virtual worlds in their real-world exhibits and programming. Why then go to the trouble of creating multi-user, online virtual spaces? Is there something about these social 3-D spaces that enables online visitors to experience science exhibits differently than via 2-D web sites and interactives?

Designing for multi-user-enabled web sites requires consideration of real-time interpersonal communication. In the context of current Internet methods, this could be user-created personas/identities, chat, messaging, videoconferencing, and/or games. And even if you don’t attempt to create games or game-like experiences online, you will need to think about online content and exhibit design in the context of how multiple visitors might experience those things together.

Despite those concerns, and others related to costs and technical requirements, many museum professionals feel a need to create a more social Internet and to widen their online exhibits to include more of this element. Multi-user 3-D virtual worlds allow “face to face” interaction between web users around the world, in spaces that are representational, abstract, or completely imaginary. They also offer a way for museums to stay in touch with community members and casual audiences and to design and present content that’s relevant for and interesting to those audiences in a personal way.

Predating Web 2.0, most 3-D virtual worlds have, at the core of their user-experience design possibilities, built-in tools and methods for collaboration and user-created content. As a developer of content and experiences in virtual worlds, you will need to think about balancing the elements of 3-D interaction, real-time communication, and user-created content. Each of these elements is familiar and powerful by itself. By bringing them together, and by designing content and experiences that leverage how they work together, you can create personalized and social experiences and learning opportunities for your online visitors.

At the Exploratorium, media creators and educators have been experimenting in Second Life (SL), a rapidly growing (9 million+ registrants to date), massively multi-user, 3-D virtual world and online community (http://www.secondlife.com). This unique space is not a game, but an open-ended environment where all the content is created by the members of the community, or “residents.” (Note: To access the secondlife:// URLs referenced in this article, you must have the SL client software installed on your computer.)

SL makes experiences of the 3-D Web accessible not only to content creators, but also to a web-savvy public. In SL, users navigate their “avatars” (virtual-world characters) through the world’s virtual landscape. Through a spatialized audio system, SL residents can now speak to one another using microphones connected to their computers. This mix of real-world and virtual-world realities allows participants to further personalize their experience.

Moving into Second Life

On March 29, 2006, the Exploratorium presented a live webcast covering a total eclipse of the sun as viewed from Side, Turkey (www.exploratorium.edu/eclipse2006/index.html). Telescopic views of this rare sun/moon/earth alignment, created in collaboration with NASA’s Sun-Earth Connection Education Forum, were broadcast with scientific commentary via satellite, television, and Internet streaming to hundreds of (Continued on page 10)
Embedding Virtual Reality in Exhibitions: A Perspective from Paris

By Marc Girard

From its opening in the mid-1980s, la Cité des Sciences et de l’Industrie in Paris has been an European pioneer in using interactive, multimedia simulation to achieve learning objectives. Early on, we created a department of multimedia design that is still an important part of our exhibition design division. Our multimedia stations not only offer visitors individual and customized access to scientific content; they also allow us to present and explain animated models of hidden technical devices and to show scientific discoveries invisible to the naked eye.

With the Climax exhibition on global warming in 2003, la Cité reached a new stage in using immersive environments to inform visitors. This 13,000-square-foot temporary exhibition included an immersive video show that illustrated climate change mechanisms and effects through virtual reality (VR) images showing the possible consequences of global warming. A smaller room hosted an interactive simulator where visitors could vary the parameters of different mechanisms and measure for themselves the effect on global climate.

The exhibition attracted 700,000 visitors. Public surveys showed that visitors agreed with our choice of VR images to illustrate scientific models and predictions. They considered this an appropriate medium for presenting scientific research based on computer simulation. But they also felt a need for a more personal involvement with the topic; in response we added to the exhibition some recommendations about what one should or not do to have a positive impact on the environment.

We have continued to blend VR experiences with on-site programming. From May through August of this year, we presented on four occasions a virtual, 3-D discovery program on Egypt’s pyramid of Cheops as part of a live show in our Omnimax dome. A French architect and archaeologist, Jean-Pierre Houdin, had put forward a new hypothesis regarding the building of this pyramid; he believes it was constructed from the inside out. To verify and validate his hypothesis, Houdin used a powerful computer-assisted design (CAD) program developed by Dassault Systemes for use by companies like Boeing and Toyota in complex industrial projects.

The Dassault Systemes software produces, in real time, gorgeous 3-D virtual images of the Cheops pyramid. Visitors wearing 3-D glasses can “explore” the structure while seated in our dome theater. The 4,300-square-foot concave image created a tremendous immersive experience— but that in itself was not unusual.

Our innovation was to have Houdin himself on stage—conducting the show, commenting on images calculated in real time with the help of seven computers and six stereoscopic video projectors, and explaining his scientific approach. This was an extremely effective tool for the archaeologist to use in interacting and communicating with a large, nonspecialist audience. The public response was so enthusiastic, and the learning potential seems to us so great, that we plan a new version of this show especially suited to the needs of school groups.

VR will also play a role in a large temporary exhibition about epidemics due to open at la Cité in October 2008. Each visitor will wear an electronic tag, and we are designing an immersive game room in which the movement of and interaction between visitors will itself provide information about viruses, human responses, and treatment. Information about the simulated viral condition of visitors will appear projected on the floor of the room, while information regarding the environmental role of disease will be projected on the walls. The effect will be like a huge video game, in which visitors become their own avatars.

We chose this unconventional design because our public surveys suggest it will appeal to younger visitors already familiar with digital media like video games or interactive web sites. But we also believe it will help us communicate information on epidemics using media suited to such a complex and timely theme.

Although we don’t yet have a large body of research establishing the learning effectiveness of virtual and immersive environments, la Cité des Sciences intends to do further experimenting with VR.

Of course, we use these techniques because they are appealing and powerful and our audience expects them, but we must also pay attention to offering more than just exciting shows. Apart from their appeal as illusions, immersive VR simulations must remain a way to promote understanding of complex scientific and technical discoveries.

(Continued from page 8) thousands of viewers worldwide. We also created an
overnight program at our museum in San Francisco where the public came
to view the live eclipse webcast.

This event seemed a perfect opportu-

ty to try our first venture in Second Life. We streamed the program
into several locations in SL and created
a companion set of in-world ex-

hibits. The combination of live streaming video, a unique viewing en-

vironment, interactive exhibits, and
in-world hosts to answer questions
provided a virtual-world experience
that mirrored our real-world museum
programming. The 65 SL residents
who attended remained actively en-
gaged throughout the one-hour pres-
entation. This showed us that a live webinar-viewing experience in-world
could attract and engage SL visitors.

Our next SL undertaking was to create the ‘Splo, an industrial-looking
space in an in-world urban setting filled with more than 100 3-D exhibits (secondlife://Midnight City/
176/58/26). Some of these exhibits were new to the Web; many would be
hard to make in a real-world museum.

Encouraged by positive visitor expe-

riences at the ‘Splo, as well as by the
response to the eclipse event, we were
inspired to establish a larger SL pre-

sence for the Exploratorium and develop
relationships with other education-
al content creators working in-world. We have since built an entire island called Sploland (secondlife://Sploland/
175/75/25), filled with both serious and humorous exhibits, and have
hosted two more live SL events.

The first of these, in November
2006, was an astronomy presentation
offered in conjunction with the Na-
tional Optical Astronomy Observatory
(NOAO) at Kitt Peak, Arizona. We
offered a live streaming webcast of tele-

coscopic views of the transit of Mercury
as it crossed the face of the sun. In SL,
the event was hosted at the Interna-
tional Spacelift Museum (secondlife:
//Spaceport Alpha/48/78/241) by ‘Splo
avatar-scientist Patio Plasma (an Ex-

ploratorium physicist and educator in
real life), who demonstrated the

phenomena using an interactive, 3-D planetary-orbit model.

We also presented a Pi Day event
on March 14, 2006, jointly celebrating
Einstein’s birthday and the number pi
(3.14). In the real world, the Explora-
torium has hosted Pi Day events for
more than a decade. This year, staff
built dozens of Pi Day exhibits specifi-
cally for SL, including PiHenge (like
Stonehenge, but with pi-lithons replac-
ing trilithons) and a giant pi

sculpture that spit out cherry pies. Avatars could try “hands-on” activities,
such as building a pi glass, a cylindrical drinking glass as tall as its circum-
ference. Exploratorium visitors could watch the SL goings-on in our real-
world theater and ask questions about the
virtual world, and Pi Day events at
the museum were streamed into SL,
where avatars could query staff avatars
about them. In San Francisco, visitors
were served slices of pizza and dessert
pies; in Second Life, avatars received
free Pi Day T-shirts.

Most recently, we have launched
Exploratorium Island (secondlife://
Exploratorium/163/124/23), a multi-
purpose space where we plan to build
and prototype exhibits, present public
programs, and offer workshops from
our teacher-education programs. Ex-
ploratorium Island and Sploland are
part of a group of science-technology-
themed SL locations called SciLands
(http://scilands.wordpress.com), a sprawling campus where avatars can stroll (or fly!) around and engage in experiences across a range of topics. SciLands in-
cludes both real and virtual institu-
tions; it has a governing board to over-
see the addition of new content areas.

What you can do in SL

So what kinds of online exhibits can a
virtual-world science center offer that
visitors can’t get in real life? Here are a
few ideas we’ve tried with success.

1. Move the visitor around

In the real-world Exploratorium,
there’s an exhibit where visitors walk up
to an upside-down photo of TV per-
sonality Vanna White. At first, there
doesn’t seem to be anything wrong
with Vanna, but when you rotate her
photo, you see that her eyes and
mouth have been cut out and placed
upside-down in her otherwise right-
side-up face. The effect is grotesque
disturbing. The exhibit shows that people analyze pictures of faces in
pieces, looking at the eyes and mouth
independently. In our real museum, we’ve made two copies of the exhibit.
In one, the viewer rotates the photo-
graph as in the real world; in the other, the avatar gets rotated instead—a
memorable experience for SL residents.

Another exhibit allows avatars to ei-
ther watch the orbit of Comet Halley,
or ride the comet as it races away from
the sun, slows near aphelion, and fin-
ally plunges back toward the sun. Most
choose to ride the comet.

2. Change the scale of objects

Unlike in the real world, it’s easy to
change the scale of natural phenomena
in the virtual world. For example, to
help visitors understand eclipses, we
built a scale model of the earth/moon
system in SL. We hung an earth model
in space (easier to do in a virtual
world!) and, at the same scale, hung a
moon model 30 meters (100 feet) away.
People visiting the exhibit, in-
cluding real-world astronomers, have
noted that they had no true apprecia-
tion of Earth’s scale relative to the
moon before encountering this exhibit.

A virtual world can also offer access
to the very small: One inspired SL resi-
dent built a model of the Brownian
motion phenomenon, which describes
the random motion of particles. In his model, four cubes that would be a few nanometers across in the real world tumble and spin inside a transparent cube 10 meters on a side. Taking advantage of what we’d learned about a virtual visitor’s scale-of-reference experience, we suggested allowing avatars to ride the cubes. The view from a particle undergoing Brownian motion and rotation in 3-D makes for a wild ride.

3. Make exhibit information portable
Museums in the real world often struggle with how to present interpretive materials with their exhibits. Too much information for one visitor might not be enough for another. In a virtual museum, you can create rich textures offering visual or textual information adjacent to or on exhibits, or you can attach “notecards” that avatars can read and discard or save in an “Inventory” file. Notecards can be linked to other notecards or to web pages, offering deeper levels of detail, examples, references, or links to real-world museums.

Both notecards and objects can have scripts attached that offer mementos or artifacts. You can give a visiting avatar a talking book or a T-shirt or hat customized with museum graphics. The ability to integrate textual and other external web content into the virtual experience is an active area of development for Linden Labs, creators of SL.

4. Let visitors experience dangerous situations, or take them to remote locations.
It can be tricky to explore the inside of a nuclear reactor core in real life, but avatars in Second Life need have no fear flying around inside a 3-D model of a working nuclear reactor. Bringing live audio and video from expeditions into SL simulations offers a unique way to engage visitors and connect them to activities at inaccessible locations.

Exhibits and social interaction
Visitors to virtual-world museums are more than just usernames; they’re “residents” who can express an identity and demonstrate interest in a museum’s ideas and exhibits. Through design,

Digital Planetariums for Astronomy Education
By Ka Chun Yu and Kamran Sahami

One of the challenges in teaching astronomy is that fundamental concepts of the science are notoriously difficult to learn. It doesn’t help that naive notions about basic things like the phases of the moon, the shape of Earth, and the progression of the seasons, are pervasive among students.

Researchers have found that such mental models, in true constructivist fashion, evolve over time. The earliest ones reflect views that make sense to young learners—i.e., “the earth is flat.” When children learn from authority that “The earth is round,” they assimilate this new fact into the preexisting model. It is rare for an earlier model to be displaced completely. Additional information can merge into and further modify the mental model, but the original framework is rarely thrown out entirely.

Most of astronomy deals with phenomena outside people’s everyday experience, so any understanding of the science requires construction of mental models. If errors creep into the initial process, it will be much more difficult for these notions to change with subsequent teaching. And because much of traditional instruction is two-dimensional, it is usually up to the student to conceptualize core astronomical concepts, like phases of the moon and seasons, in three-dimensional terms.

Hand-held physical models can help, but in general it is difficult to orient oneself from one perspective to another.

Computer modeling and visualizations have become important tools for correcting unscientific ideas about astronomy. They allow users to explore phenomena from a variety of frames-of-reference—from going inside a model to see local detail to viewing it externally to gain a global perspective. Visualizations can also transition seamlessly between small and large scales, a help in understanding astronomical distances, another challenging topic for students.


A new class of digital theaters has emerged in the past decade as a natural venue for computer-generated visualizations. These digital, video “fulldome” planetariums have grown explosively—with more than 300 constructed worldwide since the first, the Adler Planetarium’s StarRider Theater, opened in 1999. Many fulldome theaters have real-time simulation software that can re-create an interactive virtual universe inside the dome. Such immersive environments allow audiences to gain direct experience about places or phenomena difficult or impossible to observe in real life.

The ALIVE project
The authors are principal investigators of ALIVE (Astronomy Learning in Immersive Virtual Environments), a National Science Foundation-funded project at the Denver Museum of Nature & Science’s Gates Planetarium and the Metropolitan State College of Denver. This research program is the first to evaluate the effectiveness of digital planetariums for the teaching of fundamental astronomy concepts.

Our study is following the learning gains of undergraduate astronomy students at Metro State over the course of a semester, with evaluations conducted for classes that see immersive (inside the planetarium) and nonimmersive (shown in
undergraduate astronomy students at Metro State over the course of a semester, with evaluations conducted for classes that see immersive (inside the planetarium) and nonimmersive (shown in the regular classroom) visualizations.

Because ALIVE is only in its second semester of data collecting, it is too early to give any significant findings. However we have noticed a difference in motivation and engagement for those students who visit the Gates Planetarium, confirming benefits noted by researchers like Chris Dede at the Harvard Graduate School of Education, who has studied the use of virtual-reality tools for education.

What the learner already knows is critical for determining what and how to teach. The instructor can present evidence directly conflicting with incorrect ideas, but only when students are dissatisfied with their incorrect notions can their thinking begin to evolve to more useful scientific models.

In our research, we have paid close attention to the kinds of misconceptions described at the start of this article. We also uncovered new misconceptions in oral interviews with more than 100 students. The curriculum we have developed for fulldome presentation takes care to explicitly address the most common of these.

The work we are doing with college students has implications for informal science education as well. Planetarium staff who are aware of the kinds of misconceptions that audiences bring with them can redesign their presentations to avoid reinforcing those notions. The most important product from ALIVE will be an understanding of how to use digital planetariums most effectively to achieve this end.

The audience for the 3,000 traditional and digital planetariums now operating worldwide is in excess of 100 million people. As more facilities convert to digital projection, the potential impact on informal science education will grow as well. It is our goal to disseminate “best practice” techniques to all interested fulldome planetarium lecturers and operators, and to maximize the effectiveness of this new technology.


### Is Second Life Right for Your Museum?

**Advantages of getting into Second Life...**
- Extends reach of content and community to a growing online audience
- Gets your museum involved in the social aspects of the Internet
- Expands your audience on an international level
- Appeals to Gen X, youth, and gamer cultures
- Allows user-generated content
- Enables collaboration
- Allows wandering/linking/searching activities that promote discovery
- Offers evolving content and social networks that enable emergent patterns and interaction models
- Offers built-in economy for donations and sale of content, merchandise, or event ticketing

**Compelling technical features...**
- Persistence of objects and identity
- Rich media content support
- Built-in scripting language, possibility of support for new scripting languages
- Ability to interface with external data sources
- Up-to-date hardware capabilities
- In-world building tools that keep costs down and are easy to learn and use
- Infrastructure actively supported and enhanced by developer
- Support for internationalization
- Open-source client that allows development of customized browsers and features
- Active third-party development that contributes to overall platform development and extensibility

**...And a few disadvantages**
- Limited audience compared to other electronic media, including the Web
- Technical barriers to entry (hardware/broadband requirements; ease of use)
- Not yet seamlessly integrated with other web media or virtual worlds
- Openness to live content/content modification and associated consequences, a la Wikipedia
- Moderated events can be challenging
- Can’t accommodate large numbers of participants in a single space
- Overall stability issues.—P.D. & R.J.R.
Virtual Reality and Immersive Environment Resources

READINGS


• Kafai, Yasin B. “Playing and Making Games for Learning: Instructionist and Constructionist Perspectives for Game Studies.” Games and Culture 1, no. 1 (January 2006). Game theory from an associate professor at the UCLA Graduate School of Education & Information Studies.


• Shaffer, David Williamson. How Computer Games Help Children Learn. New York: Palgrave Macmillan, 2006. Proposes using role-playing games to allow learners to enter into the “epistemic frame”—knowledge, skills, and values—of different professions and solve real problems.


WEB SITES

The Education Arcade: http://educationarcade.org/games

A collaborative of game designers, academic advisors, and MIT education researchers working to blend advanced math, science, and humanities content with state-of-the-art game play. Projects include Revolution, a multiplayer role-playing game based on events in colonial Williamsburg; Supercharged!, a physics game in which players must navigate a spaceship in a 3-D environment; several augmented-reality (AR) games; and new products emerging from their Gambit and iCue partnerships.

Games, Learning, and Society: http://gameslearningso c iety.org/index.php

The Wisconsin-based Games, Learning, and Society (GLS) group comprises academic researchers (many from UWM), interactive-media or game developers, and government and industry leaders who investigate how interactive-media environments operate, how they can be used to transform the ways we learn, and what this means for society.

Immune Attack: http://fas.org/immuneattack/

This educational video game was funded by the National Science Foundation and jointly developed by the Federation of American Scientists (FAS), Brown University, and the University of Southern California. Immune Attack was introduced at the 2005 Summit for Educational Games. Other FAS games include Discover Babylon and Multi Casualty Incident (MCI) Responder, a training program for real-world firefighters.

River City Project: http://muve.gse.harvard.edu/rivercityproject/index.html

Research papers from the long-term multi-user, virtual-environment (MUVE) educational project directed by researchers at Harvard's Graduate School of Education are posted here.

Scienctr.org: www.scienctr.org

Scienctr.org, an ASTC member, is Cornell University's online compendium of virtual worlds and interactive web sites, offering resources and programs for U.S. educators.

Second Life: www.secondlife.com

Web portal to the massively multiplayer, online virtual world launched by Linden Lab in 2003. More than 9 million “residents” had been registered as of September 15, 2007.

T.H.E. Journal: www.thejournal.com

The October 2007 online issue of this educational technology journal features articles on immersive, 3-D simulation, MUVE, and other next-generation teaching/learning technologies.

Virtual Community of Learning and Care: www.ase.tufts.edu/devtech/vclc.html

A project of Tufts University's DevTech Research Group, VCLC is exploring the potential of virtual environments to enable youth to create online content and participate in virtual communities.

Web Designs for Interactive Learning: www.wdlil.org

Funded by NSF and maintained by the Cornell Lab of Ornithology and the Exploratorium, WDL is an online forum and source of information for educators who are designing, developing, and evaluating interactive web sites.

WolfQuest: www.wolfquest.org

Beta site for an NSF-funded immersive, multiplayer 3-D video game that teaches wolf behavior and ecology. Developed by Eduweb and the Minnesota Zoo, WolfQuest is scheduled for free distribution in December 2007. The web site will be customized for each participating U.S. science center or museum.
Changes in Attitudes:
Designing for Visitor Expectations

By Nina Simon

Most of this journal, appropriately, is about things museums do. This article isn’t. It’s about things visitors do—and things museums might do in response.

It’s an open question whether your museum should be incorporating gaming, virtual worlds, or physical immersion in its galleries. But there’s no debating that these things are already part of visitors’ lives. Adults play games on cell phones on the way to work. Kids colonize virtual worlds before they know how to type. And whether museums condone it or not, people are blogging, sharing, and mashing up their museum visits on the Web.

Does that mean we should start posting to YouTube videos of museum execs whooping it up in the bubble area? Not necessarily. But we’d be fools not to understand and find ways to leverage these emerging attitudes.

Note the focus on attitudes, not actions. Initiatives to “meet the people where they are” often port everyday actions into museum experiences: Visitors use cell phones; museums should put tours on cell phones. Visitors play in virtual worlds; museums should maintain virtual presences.

But such an approach focuses only on the technology, not the expectations and attitudes inherent in using that technology. Instead of worrying about getting on YouTube or building the next Club Penguin, museums should consider how these experiences affect the way people approach museums.

The three P’s

As I see it, there are three defining “Ps” in contemporary experience with content: play, personalization, and participation. Play, meaning the incorporation of game mechanics into everyday activities and functions. Personalization, meaning services that recognize and uniquely respond to you. Participation, meaning opportunities for consumers to evolve into judges, journalists, and community members around content. Each of the P’s represents an attitudinal shift due to outside forces, most significantly the Web. Let’s take a closer look.

Play

The game industry, once a haven for zombie-killers and cliff jumpers, has diversified over the last five years in content, platform, and player profile. Construction workers use simulators to learn on-the-job safety skills. Middle-aged commuters play mobile games on the subway. Families get fit together with Nintendo’s Wii.

But it isn’t just games that have changed; products and services now incorporate gaming too. Consider the LCD screens on new car dashboards that record speed, distance traveled, and gas usage. A speedometer, odometer, and gas gauge serve the same functions. But the LCD interface, which shows real-time mileage instantly and over time, adds a fundamental game mechanic, feedback, to the experience. Owners now talk about beating their previous mileage “score,” vocabulary new to the art of driving.

Amy Jo Kim, of the game design firm Shufflebrain (www.shufflebrain.com), has described five basic game mechanics she claims can be used to make all kinds of nongame experiences more appealing—feedback, collecting, scoring, trading, and personalization. It’s no accident Netflix greets you by name, tracks your purchases, stores your addresses, and recommends new items based on your preferences. Game mechanics transform online shopping into a personal experience—and Amazon into an attentive content provider.

Have you visited an exhibition that addresses you by name? On ASTC’s ExhibitFiles.org site, Jim Spadaccini reflects on his experience with 6 Millards
Participation

Participation is, presumably, the area in which science museums and centers are most proficient. But this P is not synonymous with “interactive.” In the era of Web 2.0, participation means engagement with content as creator, judge, and distributor, not just consumer. Participation technology is pull technology. Blogs, virtual worlds, and social networking spaces allow visitors to share their opinions and creations with each other and, ultimately, with content providers.

Online companies understand the role of participation in enhancing the value of services. Product distributors often place “what other people like you bought” ahead of “what professionals recommend” in their metrics for suggesting new products to users.

Internally, the museum debate about whether or not to blog, to incorporate visitor-generated content, and so on may seem to be about protecting museum assets and promoting a safe, welcoming environment. But to people on the outside, it looks like stinginess, an unreasonable protection of content and messaging. When museums don’t provide a forum for participation, visitors use the forums they already have, reviewing places they’ve liked (or disliked) on TripAdvisor and posting their museum photographs on Flickr.

And participation isn’t just about speaking your mind. Anyone who moves from being a consumer to being a participant feels a little bit of ownership. Do users own MySpace? Of course not. But they have partial ownership of the content, which makes it feel legitimately like “their” space.

Otronicon: Celebrating Digital Media

Orlando, Florida, has a global reputation as a theme park mecca, but not many are also aware that the area is also a major simulation hub. More than 1,800 producers of simulation technology, digital media, and interactive entertainment have their home base in central Florida.

Several years ago, the Orlando Science Center (OSC), noting this concentration of related companies, began pursuing a strategic plan to become a more active showcase for local technologies. The science center would not only promote the science behind the new digital media, but also explore their potential as educational tools and drivers of economic development in the region.

Because simulations are closely allied to videogame design, we decided to highlight consumer video games as a platform for exploring the art, technology, and science behind the gaming and simulation industries. The special event we envisioned would be not just an educational symposium, or a series of video game tournaments, or a simulation exhibition, but a combination of all three—exploring how today’s digital media affect the way we live, learn, work, and play.

In January 2006, nearly 16,000 visitors of all ages and backgrounds, from across Florida and beyond, attended the first Otronicon to learn firsthand about the impact of interactive technologies. The event attracted one audience—teens and single 20-somethings, both male and female—that usually attends OSC functions only sporadically. (A year later, the multi-day event pulled in more than 18,000 attendees, and plans are under way for a third Otronicon event, to be held January 18–25, 2008.)

Beyond the fun of playing the latest game systems, like Playstation 3 and Wii, or revisiting old favorites in the Videotopia arcade, visitors enjoy a thorough introduction to the high-tech immersive media being created in their own back yard. This couldn’t happen without the support of local partners and sponsors. Over the past two years, Full Sail Real World Education (an Orlando entertainment media college) has organized career-related museum “field trips” for more than 2,000 middle and high school students during Otronicon, with workshops focused on art design, programming, and story development. (One 2007 careers session was aimed specifically at young women.) There were workshops for the general public, too, at night and on weekends.

One of the most popular categories each year is “Serious Games,” the digital immersive applications used to train soldiers, pilots, doctors, drivers, and more. Visitors can get up close with military simulators like Lockheed Martin’s F-16 fighter jet and Apache helicopter; RDECOM’s FlatWorld (re-creating the urban battlefield of downtown Baghdad); Atlantis Cyberspace’s immersive combat trainers; and the Marine Corps’ virtual shooting range. Many of these came from the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC)—an annual Orlando event that promotes cooperation among the armed services, industry, academia, and government agencies.

Nonmilitary applications, like the patient simulators of the Emergency Medicine Learning and Resource Center’s mobile SimLab and the realistic driving trainers of Raydon Corporation, also attract crowds. A highlight of the 2007 event was the multimedia stage show presented several times by James “Butch” Rosser, director of the Advanced Medical Technologies Institute at Beth Israel Medical Center in New York. Dubbed “the video game surgeon,” Dr. Rosser has done studies proving that surgeons who play videogames perform minimally invasive procedures faster and more accurately than surgeons who don’t. His Top Gun for Kids show mixes music, videogames, and surgical-skills tests to inspire youngsters to think about science and medical careers.

Besides industry sponsors, Otronicon receives support from the Orange County Arts & Cultural Affairs Advisory Council and the Metro Orlando Economic Development Commission. For information on what’s planned for Otronicon 2008, including a Video Games Live concert presented in collaboration with the Orlando Philharmonic Orchestra, visit www.otronicon.org.

Jeff Stanford is public relations director at Orlando Science Center, Orlando, Florida.
Take a risk

For museums, each of the P’s has related visitor actions. It’s up to the institution to decide when to integrate actions with attitudes. Whether designers go out on the floor and listen to visitors’ requests, or museums create/engage in games or social-networking, the result is the same. Visitors feel their contribution matters, to address visitors as unique individuals, to add game mechanics to interactives, or provide venues for their feedback.

Mostly, it just takes an attitude shift—ours. Surrendering control in favor of fostering ownership may help launch visitors out of traditional paradigms and into active, social, playful relationships with museums.

Nina Simon is an experience designer whose most recent project, “Operation Spy,” opened last summer at Washington, D.C.’s International Spy Museum. She maintains a blog, Museum 2.0 (www.museumtwo.com), about ways museums can integrate social networks and user-focused design into their institutions.

Countdown to 5SCWC

Mark your calendars for June 15–19, 2008, when the Ontario Science Centre will host the 5th Science Centre World Congress (5SCWC). Museum leaders from around the world will gather in Toronto to share ideas on “Science Centres as Agents of Change” and to explore related themes of the sustainability of planet Earth, citizen engagement and social responsibility, and the role of science centers in creating the future. A declaration of significant issues and trends in the field will be released publicly during the Congress.

Planners have put together an enriching program of keynote speakers, plenaries, parallel sessions, and social activities. The June 15 welcome reception will showcase the transformed Ontario Science Centre, including the Weston Family Innovation Centre, an edgy experience area for youth aged 14–24; TELUS-CAPE, an outdoor exploration plaza; and three permanent art installations. Confirmed keynote speakers include Sheila Watt-Cloutier, an Inuit leader and climate-change activist nominated for the 2007 Nobel Peace Prize; Mohamed H.A. Hassan, president of the African Academy of Sciences and renowned authority on the physics of wind erosion and sand transport; and Jennifer Correiro, co-founder and executive director of TakingItGlobal, a Toronto-based organization that is a catalyst for “youth-led action in the international context.” Her keynote will be linked live via the Web to youth in Latin America, Africa, and Asia.

The Ontario Science Centre has been minimizing the environmental footprint of the Congress, reducing the consumption of resources at all stages: The Toronto Convention Centre and designated hotels have aggressive waste- and energy-reduction strategies; electronic communications employed before and after 5SCWC are reducing paper usage; and a “green” levy included in registration fees will be applied to the purchase of carbon emission reduction credits, with the goal of achieving a carbon-neutral event.

Calendar

NOVEMBER

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<td>7–9</td>
<td>ASTC RAP. “Balancing the Equation = Mathematics throughout the Science Center.” Hosted by the Museum of Life and Science, Durham, North Carolina.</td>
<td><a href="http://www.astc.org/prodev/raps/astcrap/">www.astc.org/prodev/raps/astcrap/</a></td>
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<td>7–10</td>
<td>Museum Computer Network Conference.</td>
<td><a href="http://www.mcn.edu">www.mcn.edu</a></td>
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<td>28–30</td>
<td>10th Annual SAASTEC Conference. Hosted by the Port Elizabeth Science Centre, Port Elizabeth, South Africa.</td>
<td><a href="http://www.saaastec.co.za">www.saaastec.co.za</a></td>
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JANUARY 2008

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<td>25–26</td>
<td>ASTC RAP. “Reconciling Science and Religion in a Science Center: Do We Need To?” Hosted by COSI Columbus, Columbus, Ohio.</td>
<td><a href="http://www.astc.org/prodev/raps/astcrap/">www.astc.org/prodev/raps/astcrap/</a></td>
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FEBRUARY 2008

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<tr>
<td>15–20</td>
<td>5th Science Centre World Congress. Hosted by the Ontario Science Centre, Toronto, Canada.</td>
<td><a href="http://www.5scwc.org">www.5scwc.org</a></td>
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OCTOBER 2008

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<td>18–21</td>
<td>ASTC Annual Conference. Hosted by the Franklin Institute, Philadelphia.</td>
<td><a href="http://www.astc.org/">www.astc.org/</a></td>
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The Ontario Science Centre will host the 5th Science Centre World Congress in June 2008.

Online registration for 5SCWC began in mid-October, with early bird fees set at $700 for registrations received by March 30, 2008. After the conference, delegates can participate in an optional two-day program at Science North in Sudbury, with sessions including “Assessing the Visitor Experience; Immersive Visitor Experiences,” and “Connecting with the Community.”

For more details, visit the Congress website at www.5SCWC.org, and register to receive automatic updates.

**Mexican Museums Meet, Address Climate**

The 10th Annual Conference of the Asociación Mexicana de Museos y Centros de Ciencia y Tecnología (AMMCCyT) was hosted August 25–27 by the Museo El Rehilete, Pachuca, Hidalgo, Mexico. The conference theme, “New Challenges, New Responses,” specifically addressed climate change and its effects on Mexico’s environment. (Coincidentally, Hurricane Dean struck the vicinity during the conference.)

AMMCCyT is a network of 25 science centers and museums. Established in 1996, its primary task is to disseminate science and technology news and to foster new ideas within the scientific community. Members are asked to find solutions to common problems; to exchange ideas, information, materials, and human resources; to encourage professional development; and to stimulate the formation of new museums and centers in the country.

Agenda items combined the network mission with the conference theme in sessions that examined ways in which climate change is directly affecting Mexico and influencing the public’s perception of science and technology. Among the challenges discussed were social relevance, quality of information and its presentation, accessibility, marketing, financial sustainability, and audience appeal.

Walter Staveloz, director of international relations and the IGLO initiative at ASTC, gave the keynote address, asking “Why must global warming be addressed immediately? How does it relate to science centers? What outside partnerships should science centers form to play a larger role in confronting issues relevant to the public?” Staveloz cited IGLO’s participation in Live Earth last July as one example of a promising partnership.

“Positioning institutions between education and entertainment is no longer sufficient,” Staveloz said. Instead, he proposed that museums worldwide engage a new “E4” model, focusing on education, entertainment, ethics, and engagement. Said Staveloz, “We must address the ethical future of science and public engagement and ask, ‘How might science education change our way of life?’”

**‘Immersive’ Forum Set**

Have you discovered the ASTC Dimensions discussion forums in ASTC Connect? Join us December 3 for a weekend, moderated discussion on topics raised by this issue. For details or to sign up, click on the ASTC Connect tab at www.astc.org.
Grants & Awards

In September 2007, the Institute of Museum and Library Services (IMLS) announced the following awards to ASTC-member museums under its Museums for America program (all awards require matching funds):

- **American Museum of Natural History**, New York, New York: $149,207 to develop an emergency preparedness and response plan for its collections, libraries, and archives.

- **Boston Children’s Museum**, Boston, Massachusetts: $150,000 to support GoKids in Boston Neighborhoods, a program that will focus on children’s health and fitness, with outreach to low-income and minority families.

- **Burpee Museum of Natural History**, Rockford, Illinois: $52,340 for Paleo-CSI, a museum educational program that will share the science and stories behind Homer, a high-impact dinosaur specimen discovered by a recent Burpee Museum expedition to the Montana Badlands.

- **Chicago Academy of Sciences/Peggy Notebaert Nature Museum**, Chicago, Illinois: $103,046 to inventory and create a database of eight natural history collections for access by researchers and the public.

- **Children’s Museum at La Habra**, La Habra, California: $148,021 for Young at Art, a standards-based arts education program for kindergarteners through second grade students and teachers that features visual arts, music, and drama activities in classrooms and at the museum.

- **Children’s Museum of Indianapolis**, Indianapolis, Indiana: $150,000 for Global Perspectives, an immersive exhibit experience anticipated to open in 2008 that will help children and families discover needs and concerns that are shared by people and cultures around the world.

- **Children’s Museum of Pittsburgh**, Pittsburgh, Pennsylvania: $109,376 to create a new residency program, Tough Art, that will bring young artists, aged 20-35, into the museum for a three-month residency.

- **Danville Science Center**, Danville, Virginia: $148,449 to create Mobile Science Centers for communities in Virginia and Kentucky.

- **EdVenture, Inc.**, Columbia, South Carolina: $148,739 to develop and implement a community-based educational initiative to engage families in adopting healthier lifestyles.

- **Family Museum of Arts and Science**, Bettendorf, Iowa: $35,469 for physical and content redesign of The Garden, a bilingual exhibition catering to learners aged 4 and younger.

- **Florida Museum of Natural History**, University of Florida, Gainesville: $133,054 for a teacher enrichment program that provides the scientific knowledge and techniques, classroom materials, and online resources teachers need to supplement and enhance student learning in the classroom, as well as in gallery experiences.

**CLOSING THE GAP**—Why does the gender gap persist in math and science education, and how can it be closed? The Girls, Math & Science Partnership (GMSP) at Carnegie Science Center, Pittsburgh, Pennsylvania, is tackling this issue with a new gender equity toolkit aptly named The Girl Solution.

“Girls approach science in a much different way than boys do,” says GMSP executive director Jennifer Stancil. “Girls perform better when they can see the relationship science has to the broader world in which they live.”

### Grants & Awards

**By Christine Ruffo**

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**Spotlights**

**The Ornithopter in Catch the Wind uses 12-foot flapping wings to lift visitors off the ground.** Photo courtesy Museum of Life and Science

**AIR APPARENT**—Powerful yet invisible, constantly moving air currents help shape Earth’s environment. On June 16, the Museum of Life and Science, in Durham, North Carolina, opened its newest permanent outdoor exhibition, *Catch the Wind*. The four-acre exhibition features seven large-scale interactive exhibits that illustrate the influence of wind.

The centerpiece of *Catch the Wind* is the 5,000-square-foot Sailboat Pond, where visitors can take control of radio-operated sailboats. Equally engaging is the Ornithopter, a modern adaptation of a machine designed by Leonardo da Vinci circa 1485, which lifts visitors off the ground with flapping wings that model the motion of insects and birds. In Floating Rings, visitors can use air cannons to fire bursts at an array of panels covered by small shiny discs. Hinged to move freely in the wind, the disks move in response to the air, creating the impression of waves. At the Mist Garden, mist machines that make air currents visible enable visitors to experiment with moving air around objects like blocks, plants, and movable panels.

Two exhibits demonstrate the importance of wind to plant life. The 30-foot-tall Seed Tower lets visitors launch giant seed models and watch them spiral and flip to the ground, demonstrating how seeds travel from a parent tree to germinate. Steering a high-powered fan across a landscape of trees and tall grasses in Dancing Plants, visitors see how plants bend and change position to avoid being blown over.

Finally, the wooded Bird Garden features environmental artwork and bird feeders that attract native birds. *Catch the Wind* is the third of four permanent exhibitions opened as part of the museum’s BioQuest master plan, launched in 1999. Already installed are Magic Wings Butterfly House and Explore the Wild. Dinosaur Trail is scheduled to open in 2008. Major funding for *Catch the Wind* was provided by the County of Durham, the National Science Foundation, the North Carolina GlaxoSmithKline Foundation, The Mary Duke Biddle Foundation, and Hoffman Nursery.

**Details:** Greg Tenhover, marketing director, greg.tenhover@ncmls.org

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**Trading cards of women scientists are featured in The Girl Solution toolkit.** Photo by Christine Ruffo
Girls need to see science as a tool to change the world, to improve the human condition.” The Girl Solution, designed with this in mind, stresses four key elements in presenting math and science problems to girls: give the problem meaning, establish value beyond the problem itself, connect the problem to other concepts, and attach specific language to the content that has an idealistic quality or goal.

The toolkit contains a multimedia CD that features techniques to better engage girls, such as assigning group work and encouraging risk-taking; profiles of “great female difference makers” in the sciences; suggestions for classroom evaluation; and tips for parents and teachers on how to be catalysts in the process. Other materials include bookmarks, buttons, posters, and trading cards of women scientists.

GMSP has distributed 250 free toolkits to schools and girl-serving agencies and conducted a national training session for Girl Scouts USA. The Girl Solution can also be purchased or trained by visiting www.girlsmathscience.org/toolkit. The project was supported by a $100,000 grant from the U.S. Department of Education and $250,000 in research funding from the Heinz Endowment and the Alcoa Foundation.

Details: Jennifer Stancil, GMSP executive director, stancilj@carnegiesciencecenter.org

**LITTLE ASTRONAUTS**—We have all heard about the work done by the astronauts who spend months on the International Space Station (ISS). In Living in Space, a traveling exhibition from the Children’s Museum of Memphis, Tennessee, visitors can explore the daily lives of ISS crew members. The 1,200-square-foot exhibition is designed to show that living in space is challenging and takes cooperation, but also can be fun. On entering, visitors learn about crew schedules and are encouraged to create their own “onboard short-term plan,” deciding what to include in their planned day in space. The exhibition is presented in three parts:

- **In Living in Space**, children learn about the basics: eating in space, using the bathroom, and getting ready for bed. Activities here include preparing a meal and strapping oneself into a special sleeping bag to keep from floating around the microgravity environment.
- **Working in Space** allows visitors to simulate crewmember tasks. Options include docking an incoming space shuttle, completing an experiment using audio instructions from the payload operations center, and using a remote arm to place a small action figure at a simulated workstation along the station’s exterior.
- **Playing in Space** features video footage of astronauts enjoying weightlessness onboard the ISS. Visitors can also choose “fun” items to pack for a trip into space, taking into account available space and weight and the safety of materials.

After closing in Memphis on December 16, the exhibition will travel to members of the Youth Museum Exhibit Collaborative. It will be available for rental by other museums beginning in late 2010. Primary funding for the $315,000 exhibition was provided by the Assisi Foundation of Memphis. Technical assistance was provided by NASA.

Details: Randy McKeel, director of public relations and marketing, randy.mckeel@cmom.com

**Gateway to Science Center, Bismarck**, North Dakota: $149,971 to build on existing partnerships with the Bismarck Public School District, the Bismarck Parks & Recreation District, Dickinson State University, and the University of Mary to present hands-on science, technology, engineering, and math (STEM) activities for elementary school students enrolled in after-school-time programs.

**Lake County Discovery Museum**, Libertyville, Illinois: $45,000 to support schematic designs for interior renovation and interpretation of the Great Barn at the Bonner Heritage Farm.

**Long Island Children’s Museum**, Baldwin, New York: $147,750 for Be Together, Learn Together, a proposed partnership of the museum with the Nassau County Department of Health & Human Services and Nassau County Family Court to support children and families served by local social services agencies.

**Louisville Science Center**, Louisville, Kentucky: $149,775 to reinvent and fabricate Splash! a science-based play exhibit in the KidZone exhibit space for young children.

**Mary Brogan Museum of Art and Science**, Tallahassee, Florida: $150,000 for Open Collections: A Lifelong Learning Project, a program designed to make the museum accessible to eight underserved counties by providing online access to collections and corresponding educational materials.

**New Mexico Museum of Natural History and Science**, Albuquerque: $143,957 to develop a coalition of educational institutions around the city to plan and implement Family Days at museums and other informal learning sites, with an emphasis on science literacy for Hispanic families.

**New York Botanical Garden**, Bronx: $140,000 to complete the Flora Borinque Digital Herbarium and Library Project, which involves digitizing and making accessible via the Internet the collections in its herbarium and library.

**Pacific Science Center**, Seattle, Washington: $129,353 to expand and deepen Discovery Corps, its pilot program for high school age students.

**Peabody Museum of Natural History**, Yale University, New Haven, Connecticut: $144,030 to expand its Evolutions (EVOking Learning and Understanding Through Investigations Of the Natural Sciences) after-school program to engage students in grades 8–12 from groups traditionally underrepresented in the sciences.

**Sciencecenter**, Ithaca, New York: $74,900 to develop, evaluate, and disseminate a series of activities on global warming. Products will be disseminated and promoted to museums internationally via ASTC’s IGLO online Global Warming Toolkit.

**South Dakota Discovery Center and Aquarium**, Pierre: $145,619 for HOP II: More Hands-on Science, Literature & Art for South Dakotans, a traveling program that delivers science, literature, and art experiences to South Dakota’s rural and reservation communities via their local libraries.
The Buffalo Society of Natural Sciences, which oversees the Buffalo Museum of Science and the Tifft Nature Preserve in Buffalo, New York, has appointed Mark Mortenson president and CEO. A 20-year veteran of the Walt Disney Co., Mortenson was most recently vice president, global operations management, for Disney’s corporate operations and real estate. He replaces Carroll Simon, who had served as interim president since January 2006.

Rejoining Canada’s Science North as science director is the museum’s founding director, David Pearson. Pearson had been teaching earth sciences at Laurentian University since 1986, while continuing to serve the museum in several capacities. He replaces Alan Nursall, who left in August to start his own consultancy.

At the New York Hall of Science, Queens, former executive vice president of programming and planning Eric Siegel has been promoted to director and chief content officer. Siegel will oversee exhibits and programs, lead strategic planning, implement grant-funded initiatives, and represent the Hall externally. Marilyn Hoyt continues as museum president.

At the Maritime Aquarium at Norwalk, Connecticut, Robert Griesmer has been promoted to the newly created position of chief operating officer. Griesmer has been with the aquarium since its startup in 1987.

Timothy E. Johns is the new president, director, and chief executive officer of the Bishop Museum, Honolulu, Hawaii. Most recently COO for a private estate, Johns formerly chaired the state’s Department of Land and Natural Resources. He succeeds William Brown, who left to head the Academy of Natural Sciences in Philadelphia.

Elizabeth Pierce has joined the Cincinnati Museum Center as vice president of marketing and public relations. A former director of marketing and PR for UC Surgeons, Inc., Pierce has worked in the past for several museums and nonprofits. Her predecessor, David Duszynski, will now focus on operational and visitor strategies for the Ohio museum complex.

The new NSF-funded Center for Advancement of Informal Science Education (CAISE), based in ASTC’s Washington, D.C. office, has chosen its staff. Director Ellen McCallie, who will assume her duties full-time in January, is completing her doctorate in the CILS program at Kings College London. McCallie’s background in informal science education includes a stint as scientist/presenter on the BBC TV series “Rough Science,” as well as work at the Missouri Botanical Garden and the Natural History Museum, London. Trained as a botanist, she has done field work in Indonesia and the Amazon River basin. Project manager John Baek, a former middle school science teacher, most recently worked as an e-learning specialist at George Mason University (GMU), Fairfax, Virginia. Baek has his Ph.D. in instructional technology and design research from GMU.

ASTC also has a new staff member, grants accountant Monica Jones, who joined us in September. Jones worked previously as a contracts and grants administrator in the Office of Sponsor Programs at Virginia Commonwealth University, Richmond.