Environmental Awareness

What Can Science Centers Do?

A Sustainable Strategy: Tracking the Triple Bottom Line
A Children’s Museum Goes Green: The Path to LEED Certification
Walking the Walk: Conservation Practices at an Environmental Science Center
What’s Reasonable to Expect? Gauging Visitors’ Grasp of Conservation Messages
Changing Minds: Learning Outcomes in Environmental Education
Acting Locally: How Science Centers Can Make a Difference
In a 2003 report, Complex Environmental Systems: Synthesis for Earth, Life, and Society in the 21st Century, the National Science Foundation identifies understanding of the relationships among people, ecosystems, and the biosphere as key to meeting environmental challenges. We cannot begin to solve problems like climate change, degradation of freshwater resources, loss of biodiversity, and the globalization of disease, the report says, until we become aware of the “footprint of human activity.” Efforts by science centers and museums to help visitors (and their own staffs) see that footprint more clearly are the subject of this issue.

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Cover: Where do I fit in the natural world? Visitors find answers in environmental exhibits and programs at urban, suburban, and rural science centers. Photos courtesy the Children’s Museum of Houston (top, left and right) and the Putnam Museum of Natural History and Science (bottom).

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A Sustainable Strategy:
Tracking the Triple Bottom Line

By Nancy Stueber

In 2001, as part of our strategic planning process, the staff of the Oregon Museum of Science and Industry (OMSI) adopted a strategic value of “sustainability.”

Sustainability and its correlate, “sustainable development” (SD), are not new concepts. They had their origins in the public sector, particularly at the international level, more than 30 years ago, and they have continued to evolve as the business community has seen advantage in paying closer attention to the social and environmental results of its actions. Perhaps the best-known explanation of SD can be found in Our Common Future, the 1987 report of the U.N.’s World Commission on Environment and Development (known as the Brundtland Commission). The report defines it as “development which meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Many organizations have subsequently adopted versions of this definition, along with another SD term, “the triple bottom line.” British conservation expert John Elkington coined that phrase in 1980 to refer to “a framework for measuring and reporting corporate performance against economic, social, and environmental parameters.”

It was while participating in workplace discussion groups offered by the NW Earth Institute that OMSI staff encountered a science-based model of sustainable development in the work of The Natural Step. TNS is an international advisory and research organization founded in Sweden in 1989 by an oncologist who had correlated cancer rates in children with increases in environmental toxins. The group works with some of the largest resource users on the planet to design solutions, models, and tools to accelerate global sustainability.

TNS acknowledges that humans are threatening themselves by degrading the natural systems of which they are part, but holds that it is possible to change the situation through “Four Simple Principles.” Briefly stated, these principles are that “in a sustainable society, nature is

Sustainable Exhibits: Keeping the End in Mind

By Ray Vandiver

With initial funding from Intel and the National Science Foundation, OMSI is currently developing the Tech Hall, a new permanent exhibition designed to help visitors explore their relationship with technology at both the personal and the societal level.

Tech Hall is scheduled to open in 2004. In line with our triple-bottom-line commitment, one focus of the design process will be on the end life of the exhibition.

There are three main ways to make an exhibition sustainable:
• Design components so that they are easily updatable—that is, you can change content without changing structure.
• Make exhibit components standard, allowing interchangeability of parts.
• Choose fabrication methods and materials that make recycling easier at the end of the exhibition.

Our goal for Tech Hall is for 80 percent of each exhibit either to be made from recycled materials or to be itself recyclable and/or reusable. Fabrication methods will be chosen with an eye to final disposal of the exhibition; for example, materials will be bolted together rather than glued, so that they can be easily separated for recycling.

Material choices will be made based on composition, durability, and how well the manufacturer’s factory rates with regard to environmentally friendly practices. In addition, one educational thread of the exhibition will be to interpret these construction methods and materials and show how they align with sustainable building practices.

—Ray Vandiver is vice president of exhibits at OMSI.
not subject to systematically increasing (1) concentrations of substances extracted from the earth’s crust, (2) concentrations of substances produced by society, [and] (3) degradation by physical means, and that, in that society, (4) human needs are met worldwide.” After gaining widespread acceptance among Swedish municipalities and corporations, the TNS principles and approach began to spread. The first U.S. group was started in 1995 by entrepreneur and environmentalist Paul Hawken.

**Identifying the need**

OMSI’s staff resonated with The Natural Step’s approach. We believe that science centers are agents of social change and that, as trusted educational institutions, we have a tremendous opportunity to present current science in meaningful and relevant ways. We also believe we have a responsibility to lead change by modeling business practices that are socially, economically, and environmentally responsible.

In our strategic planning sessions, we decided that living the value of “sustainability” meant that we must consider the “triple bottom line” in all of our decision-making processes. We agreed to pass our strategic business decisions through three filters:

1. Does the activity help us meet community needs?
2. Does it promote our financial health?
3. Does it demonstrate environmental stewardship?

We wanted to be able to answer yes to all three.

To embody this commitment, we decided to develop a Walk the Talk Initiative, in which teams of staff would meet to look inward and assess our current practices. As facilitator and guide, we engaged Axis Performance Advisors, a Portland organizational-development firm that specializes in this type of work. Staff read and discussed their Making Sense of Sustainability and other Axis publications.

In our initial conversations, we discovered that OMSI already had some systems in place to support a triple-bottom-line approach. In terms of financial health, we had good systems to track our economic bottom line, and we had a business-oriented culture. Social responsibility was also ingrained in the OMSI culture, and our focus was already on developing metrics to quantify our results. With our mission firmly at the core, we were starting to coordinate assessments of

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**Sustainable Retail: From Vermicomposting to Ecofriendly Packaging**

**By Greg Kamerer**

As part of OMSI’s commitment to sustainability, our retail operations department conducted a “waste stream” analysis in 2002 and determined that the museum could send 10 fewer dump loads of food wastes to the landfill each year if we composted the kitchen scraps from our café.

I discovered that Portland’s Metro (tri-county) government was awarding competitive Waste Reduction Assistance Grants for just such projects, and we were soon able to order our “vermicomposter,” a 30-square-foot, heated worm bin that has the capacity to process up to 100 pounds of food wastes per day. The active ingredient is Eisenia fetida, or redworms, capable of consuming at least half their weight in waste daily and turning it into nutrient-rich organic mulch and fertilizer.

The $18,500 grant covered not only the large bin, its outdoor platform, 45,000 redworms, and a year’s operating expenses, but also a smaller, indoor version suitable for home use. Aramark, OMSI’s food service operator, provided additional funding for the project.

Our exhibits staff developed signage to tell visitors what is happening in the big box outside and show them how they can do their own vermicomposting. We have had numerous inquiries about the process from visitors (as well as from a school district in Vancouver, Washington), and the worm castings are already enriching OMSI’s planting beds and those of our staff members.

Vermicomposting is not the only way we are reducing waste in our café. We have also begun to reduce the number of disposables used on-site and in our catering operations. We use only washable flatware. In those rare instances when we have a lot of food left over from a catered event, we donate it to a local nonprofit that runs a food kitchen. In the first year alone, we estimate that these efforts will reduce the amount of waste to landfill from OMSI by 3 to 4 tons.

Choosing conservation-minded vendors is another way to support sustainability. As much as possible, OMSI tries to purchase food certified by the Food Alliance. This nonprofit agency certifies growers and wholesalers based on environmental and socially responsible criteria. Members must use no genetically modified seed or livestock breeds, add no hormones or added antibiotics to livestock feed. They also agree to reduce pesticide use, observe soil and water conservation practices, provide safe and fair working conditions, conserve and enhance wildlife habitats, conserve and recycle nutrients, and provide healthy and humane care for livestock. OMSI is also increasing the percentage of locally produced food products served in our café and catering operations.

Retail operations includes the museum shop as well, and here, too, we have taken steps to operate more sustainably. Some products, for example, are now available both packaged and unpackaged. Considering each on a case-by-case basis, we try to order unpackaged when possible. (Of course, it does no good to carry an unpackaged product if we end up with too many damaged items.) We have committed to reuse or recycle almost all packing materials as well, and we have recently started sending a postcard to vendors who use a large amount of packing materials in their shipments, asking them to cut back on the usage.

—Greg Kamerer is OMSI’s vice president of retail operations
the programs and services we provide and to develop OMSI-wide measures of educational effectiveness.

As we assessed our environmental practices, we recognized that we already had a lot of “green” practices: recycling, reducing energy use, reducing waste, promoting alternative transportation. But we didn’t have baseline metrics in place to measure our consumption or our improvements; getting that baseline data is something we are working on now.

We also wanted to do more—to consider our supply chain and influence our suppliers to provide “greener” products and services; to purchase materials for exhibits and facilities that could be reused, recycled, or disposed of responsibly; and to restore the environment through efforts like the bioswales that collect rainwater runoff in our parking lot or the watershed improvements at our residential camps.

**Applying the principles**

The Walk the Talk teams identified two of our largest impacts to focus on: waste and CO₂ emissions. The first step was to establish a baseline for our current consumption and then to identify improvements that would also pay back financially.

These pilot projects have already produced some good results, helping us build staff awareness and providing opportunities for public education (see sidebars, “Sustainable Exhibits” and “Sustainable Retail”). We are currently working to create the metrics to help us to make the best triple-bottom-line decisions.

In this ongoing process, we have drawn on the work of science center colleagues around the world who are also engaged in this effort. We are also grateful for a strong supportive community network of businesses and organizations that are committed to sustainability and are sharing their experiences. The best part about focusing on the triple bottom line is that when we make a decision to help one of the three elements, we often help the others, too, gaining multiple benefits.

We apply the triple bottom line both internally and externally. Internally, when we make a business decision, we try to ask ourselves: Will this action be financially sound? Will it contribute to a satisfying workplace? And will it demonstrate environmental stewardship? Externally, we ask: Will this contribute to the economic vitality of our region? Does it promote social equity and well-being in our community? Can it promote environmentally preferable choices by our other stakeholders? These questions ensure that we generate the maximum benefits from our efforts, for ourselves and for the community we serve.

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_Online Resources for Sustainable Development_

**Axis Performance Advisors**

[www.pacificer.com/~axis](http://www.pacificer.com/~axis)

Click on “Newsletter” to access the article “Growing into Sustainability: From Baby Steps to High Performance,” plus useful pieces on corporate social responsibility and sustainability from the Axis Advisory e-newsletter.

**The Ecological Footprint Quiz**

[www.earthday.net/footprint/index.asp](http://www.earthday.net/footprint/index.asp)

The average American uses 24 acres to support his or her current lifestyle; the average Canadian, 17 acres; and the average Italian, 9 acres. This multilingual online quiz, created by the Earth Day Network and Redefining Progress (a California-based public policy organization), can get your visitors thinking about their personal impact on the earth.

**Museums and Sustainability**

[www.museumsaustralia.org.au](http://www.museumsaustralia.org.au)

Click on “Structure,” then “Museums and Sustainability” to access the guidelines for sustainability policy and practice adopted by the Museums Australia network in February 2003.

**Natural Capitalism**


**The Natural Step**

[www.naturalstep.org/](http://www.naturalstep.org/)

The international TNS web site includes information on sustainability; spotlights on businesses, like Starbucks and McDonald’s, that have put sustainability at the core of their model; tools designed for business, academia, government, and the media; and news of new initiatives.

**Sustainability**

[www.sustainability.com](http://www.sustainability.com)

The web site for John Elkington’s business consultancy offers introductory information on sustainability, recent news items on topics like “The Water Wars,” and a resources list with online links to SD conferences, journals, books, e-newsletters, and other references.

**United Nations Division for Sustainable Development**


Look here for information on past and future international SD initiatives, including the 1992 Earth Summit in Rio de Janeiro and the 2002 World Summit on Sustainable Development in Johannesburg, as well as details on the 2003 United Nations International Year of Freshwater.

**World Business Council for Sustainable Development (WBCSD)**

[www.wbcsd.ch](http://www.wbcsd.ch)

The Geneva-based WBCSD is a coalition of 165 international companies committed to sustainable development and the triple bottom line. The web site offers news, articles, speeches, case studies, and publications on topics like corporate responsibility, ecosystems, and risk. Click on “Sustainability & Markets” to access _The Business Case for Sustainable Development_, a 2002 WBCSD publication in pdf format.

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Nancy Stueber is president and chief executive officer of the Oregon Museum of Science and Industry (OMSI), Portland.
A Children’s Museum Goes Green: The Path to LEED Certification

By Paul Pearson

On August 29, 2002, a crew of four worked through the night on the grounds of the Brooklyn Children’s Museum, carefully monitoring the flow of groundwater from a 340-foot-deep test well. At dawn, the pump was opened to full volume. Over the next two hours, the aquifer supplied a steady flow of 57-degree groundwater at a rate of over 300 gallons per minute. The good news quickly spread to everyone involved in the museum’s capital expansion project—staff, trustees, the architect, and officials at New York City’s cultural and construction agencies. The proposed geothermal heating and cooling system, the key to creating a high-performance, certified “green” building, had found its energy source in the groundwater beneath the museum.

In 1899, the Brooklyn Children’s Museum, the world’s first museum for children, opened in a Victorian house in a Crown Heights park. The institution’s “back yard” and its natural history collection supported an early focus on teaching city children about the natural world. In 1977, the museum opened a new, environmentally themed underground building on the same site.

Today, the Brooklyn Children’s Museum is positioning itself for the future with an expansion that will double our size and attendance capacity over the next three years. World-renowned architect Rafael Viñoly has designed the 102,000-square-foot expansion/renovation—an undulating, two-story, daffodil-yellow addition that will wrap around the existing facility.

Conservation technology
Increased visibility, visitor amenities, and educational/exhibition space were central goals of the expansion project. But equally critical to an institution with a mission to “foster children’s understanding of science, the environment, and world cultures” were environmental considerations and innovative use of new building technologies.

High-performance features integrated into the expansion design will save an estimated $100,000 in annual energy costs. The geothermal heating system will feed water-to-water heat pumps for the building’s heating and cooling needs, dramatically reducing on-site burning of nonrenewable fossil fuels and emissions of airborne pollutants. It will also eliminate the need for massive on-site cooling towers, thereby lowering our acoustic impact on the surrounding residential community. Photovoltaic panels integrated into the exterior fabric of the new building will harness sunlight to provide about 2.5 percent of the museum’s electricity needs.

Computerized climate control systems will further reduce energy use. Sophisticated carbon dioxide and occupancy sensors will monitor the exhibition spaces, automatically adjusting ventilation and lighting to the number of visitors in the space at any given time. Photovoltaic cells will be tied to indoor lighting systems that dim when natural lighting provides sufficient illumination, and brighten during cloudy and nighttime conditions.

Selecting energy-conserving and sustainable building materials will add even greater benefits. Low-emissivity glass, coated with a material that keeps the building cooler in summer and warmer in winter, will be used in place of conventional window glass. Structural and finish materials with high levels of renewable or recycled content—including bamboo, cork, rubber and linoleum flooring and recycled carpet—are being used throughout.

High-performance design
Brooklyn Children’s Museum’s new building is on track for certification by the Leadership in Energy and Environmental Design (LEED) program of the U.S. Green Building Council as the first “green” children’s museum in the nation. LEED is a points-based rating system that assesses the environmental
sustainability of building designs. Crite-
ria include site development, access to
public transportation, water conserva-
tion and energy efficiency, materials
selection, indoor environmental quality,
and building commissioning process.

Balancing environmental considera-
tions and economic constraints can
pose a significant challenge to tight
capital budgets. To help inform our
decisions, our “high-performance
design” consultants used sophisticated
computer programs to simulate various
energy-modeling scenarios. The mod-
els showed that green building choices
typically translated into slightly higher
initial capital costs, but that operational
savings would begin to accrue long-
term when the more efficient systems
went online.

The New York City Department of
Design and Construction, which over-
saw municipal construction projects,
alerted our capital expansion team
to two local resources available to organi-
izations considering “going green”: (1) The New York State Energy
Research and Development Authority
offers cost-shared technical assistance
and financial incentives through its
New Construction and Green Build-
ings Programs, and (2) the New York
Power Authority finances energy-
efficiency projects for public buildings
statewide through its Energy Services
Programs. Both of these agencies
have helped the museum fund high-
performance components of our
expansion project.

A teaching opportunity
For Brooklyn Children’s Museum, the
decision to “go green” was well
aligned with our educational mission
and focus on science and the environ-
ment. Although many of the high-per-
formance elements of our building
would not be visible to the public, we
recognized that the project afforded a
unique teaching opportunity.

When our expansion is complete in
2006, visiting children and families will
be able to investigate the concepts and
processes of energy efficiency and
environmental conservation through an
Energy Exploration interactive exhibi-
tion. An outdoor area will demonstrate
how the museum harvests its solar
power, and children will be able to
manipulate materials and systems to
engineer their own model buildings
using high-performance design. Visi-
tors will also learn about renewable
resources like bamboo—chosen for our
new flooring because it is one of the
world’s fastest-growing plants.

For many years, children’s museums
and science centers have provided inno-
vative programs in environmental edu-
cation for youth and families. Brooklyn
Children’s Museum hopes that a suc-
cessful project will encourage other in-
formal learning centers to invest in
sustainable, environmentally friendly
design for their new buildings.

Paul Pearson is vice president of pro-
grams at the Brooklyn Children’s Museum,
Brooklyn, New York. He can be reached at
ppearson@brooklynkids.org.

Green Design: A Technical Primer
By Adam Trojanowski

From its planning stages, the Brooklyn
Children’s Museum project embarked on
a comprehensive effort to optimize energy
consumption, water conservation, indoor air
quality, and utilization of sustainable materi-
als. This was achieved by choosing a building
form and plan that is complementary to the
site and solar orientation. Mechanical, electrical,
and plumbing systems were evaluated in
detail to select the most appropriate and
efficient systems. The new building also
incorporates products and materials that are
renewable and recyclable and have low gas
emissions.

Ground-source heat-pump system
A new geothermal heating and cooling
system provides all the heating, ventilation,
and air-conditioning requirements for the
museum. The system consists of large, cus-
tom heat-pump air handlers, water-to-water
units, and heat-pump console units with
groundwater as heat-rejection and heat-
source medium. To ensure redundancy,
groundwater is derived from two 340-foot-
deep supply wells with submersible pumps,
and is returned to ground through two
injection wells. The system offers significant
improvement in energy efficiency compared
to traditional chiller and boiler systems, plus
additional benefits like elimination of rooftop
equipment and associated noise issues;
elimination of water treatment and plume
problems for cooling towers; and overall
space savings for mechanical equipment.

Photovoltaic system
Photovoltaic (PV) systems directly convert
solar energy into electrical power. The
project incorporates 4,700 square feet of ver-
tical panels and 1,000 square feet of roof-
mounted panels that will generate approxi-
mately 54,000 kWh per year—equivalent to
the annual consumption of five households.
Electricity generated by the panels will feed
directly into the building’s electrical system.

Water conservation
Significant reductions in potable water use
will be achieved by careful selection of water-
conserving plumbing fixtures, equipment,
and fittings. Lavatory faucet flows will not
exceed 0.5 gpm and are equipped with auto-
shutoff sensors. Waterless urinals are utilized
in all toilets. New and existing exterior land-
scaping maximizes indigenous, drought-
tolerant plantings to eliminate the need for a
permanent irrigation system.

Exterior envelope
The building’s exterior envelope has been
optimized to provide a high level of thermal
and solar protection. All glazing is specified
with a U-value of 0.29 and shading coefficient
of 0.49. The exterior walls and roof utilize
R-20 and R-30 insulation, respectively. The
architectural tile wall and roof exterior reflect
a high percentage of the sun’s radiant ener-
gy, resulting in lower cooling load.

Sustainable materials
The new building utilizes large amounts of
sustainable materials that reduce depletion of
finite raw materials and contribute to im-
proved indoor air quality. The extensively
used bamboo flooring is an example of a
rapidly renewable material. Adhesives, paints,
carpets, and composite wood products and
materials were selected to minimize off-
gassing of odorous or potentially irritating air
contaminants.

Adam Trojanowski is an engineer with
ARUP Associates, a provider of technical
and design advice for the new Brooklyn
Children’s Museum building.

For more information on “green design”
and LEED certification, visit the U.S. Green
In many ways, the museum where we work—the EcoTarium, in Worcester, Massachusetts—is the epitome of the “green” science center. Formerly known as the New England Science Center (and founded as the Worcester Natural History Society), the museum changed its mission in the mid-1980s to return to its historical focus on environmental science and awareness. The name was changed in 1998 to better reflect our new mission and offerings.

In the past five years, the EcoTarium has opened three new interpretive woodland and wetland trails on our 60-acre site. Programs conducted on the three-year-old Tree Canopy Walkway, the only one of its kind in New England [see ASTC Dimensions, May/June 2000], have become one of the museum’s most popular attractions. Environmental education sessions offered in partnership with local schools range from an “urban safari” in a city schoolyard to an exploration of ponds and streams in a suburban factory town.

In 2001, the EcoTarium received the Founders Fund award from the Garden Club of America for our naturalized meadow of wildflowers and grasses, created to replace a large swath of lawn near our upper pond. In this unique setting, staff offer programs that convey the benefits and impacts of naturalized landscapes, including pollinator biodiversity and more sustainable gardening practices.

With ecology and conservation now at the core of our programming and exhibits, it has been natural to bring the same principles to our behind-the-scenes operations. In 1999, during an annual retreat in which management and staff members meet to generate ideas for museum programming and operation, it was decided to create a “Green Committee,” an internal group whose mission is to research and promote environmental awareness and conservation practices.

#### Raising conservation consciousness

The committee’s work began with simple conservation goals: establishing a museum-wide recycling program and creating a composting system for the staff kitchens. Our visibly located compost bin also serves as an exhibit area to educate visitors about why the museum chooses to compose waste. Finished compost is used in soils programming and in the museum’s MicroDiner exhibit, where visitors can use video microscopes and other tools for a close-up view of microscopic life.

To cut down on the use of plastic and paperware, staff agreed to bring their own mugs to meetings, and the Green Committee stocked the kitchen with washable dishes, glasses, and utensils. Extending our mandate, committee members looked for ways to pool individual resources. We set up a Green Center of reusable office supplies, such as file folders, mousepads, and pocket folios, for staff and volunteer use. The center also
Sustainable Development at NMSI

By Scott Butler

In July 2002, the Board of Trustees of Britain’s National Museum of Science and Industry (NMSI) committed to champion sustainable development as a core value of the organization. NMSI comprises four museums—the Science Museum, London; the Science Museum, Wroughton; the National Museum of Photography Film & Television, Bradford; and the National Railway Museum, York—that are devoted to the history and contemporary practice of science, medicine, technology, and industry.

NMSI will become a sustainable museum and organization (1) by making itself an exemplar of economic, environmental, and social performance; (2) by building organizational knowledge about sustainable development; and (3) by creatively engaging visitors, peers, business, and government in issues and actions they can take to develop social capital and a more knowledgeable, sustainable society. To oversee the process, the trustees created the Sustainable Development Unit (SDU).

The current major challenges for sustainability at NMSI are in London, Bradford, and York. These are the places that use the most energy, create the most waste, and engage with the most people. In the longer term, sustainable development is central to the Creative Planet project that is being developed for Wroughton.

To date, the SDU has successfully worked with management to reduce energy use at these facilities by 5 percent for 2002–03. The team is now identifying what further can be done to save energy, money, and greenhouse gas emissions at every site, and to produce a long-term energy plan for the organization as a whole. To embed sustainable development practices within the museums, staff are being encouraged to join small hands-on groups, called Green Teams, at each site.

In London, the SDU worked with 30 students from Imperial College on an environmental review of the main Science Museum buildings. This work produced an action plan that is now being implemented. The museum is researching how to create more sustainable exhibitions and will share its experience and expertise with other museums and galleries. The Science Museum has also received funding to construct a solar photovoltaic roof to generate renewable electricity for a new exhibition on energy.

In the bigger picture, the SDU has put together a Sustainable Development Strategy and program plan for the next five years.

Scott Butler is Sustainable Development coordinator for the National Museum of Science and Industry; he can be reached at s.butler@nmsi.ac.uk.
Environmental Guidelines

The choices we make as exhibit designers are difficult enough when we are considering only functional issues: Will this material serve its purpose in the exhibition? Make the necessary statements? Look good? Hold up? But we must be just as critical when examining the environmental implications of that material.

Take paint or ink, for example. Not only must we consider its effectiveness in the exhibition—does it attract, create context and drama, encourage associations, provide legibility—but we also have to think about its composition. Does it contain heavy metals, such as lead, that could later contaminate groundwater in a landfill? Is it made from a non-renewable source? Does it require drying agents that release toxic fumes into the air?

Although “environmentally friendly” materials are now more common, and some manufacturers and environmental organizations have begun to compile “life cycle assessments” (LCAs)—documenting the inputs, outputs, and potential environmental impacts of a given product from raw-material acquisition to final disposal—there is no one authoritative list of environmentally correct materials. The following general guidelines, however, can help us plan exhibitions with environmental considerations in mind.

- Reduce the amount of materials
Source reduction is the best solution to the problem of municipal solid waste. If a sign will need continual updating and changing, use an easily repaintable substrate or try a chalk board. Instead of distributing flyers and handouts, allow visitors to create their own “notes,” taking away only what they need.

- Avoid toxic materials
Avoid specifying materials that require toxic production processes, such as chromed metals, pigments with lead and other metals, and chlorine-bleached papers. If a particular material is essential to the project, design so that the toxic parts are easy to remove prior to disposal or recycling.

- Design for reuse
Traveling exhibitions are usually one-shot deals, with components (and even crating) custom-designed and custom-fabricated for that project. By creating a furniture “vocabulary”—a modular standard for exhibit components—we can accommodate a variety of configurations and arrangements. Furniture can be designed in such a way that only surface treatments and detailing need to change with each exhibition.

- Use recyclable materials
Paper and paperboard, corrugated cardboard, wood, aluminum, steel, copper, glass, textiles, rubber, and some plastics can all be recycled. The outlets available to you depend on your location and your perseverance. (If the manufacturer can’t provide information about a product’s recyclability, call the trade association for that industry.) The most difficult products to recycle are those that require labor-intensive separation processes, such as plastic-backed paper or adhesive-coated laminates. But if plastic is screwed to wood rather than laminated, both the wood and the plastic could be recycled.

- Use recycled materials
Many of the materials we recycle can be purchased, in turn, already made into new products. Examples include cardboard and paper, drywall, wood products, some plastic products, aluminum, and glass. Some of these products are more expensive than similar ones made from new resources, and some standard exhibition materials, such as plastic laminates and acrylics, are not yet made of recycled materials. But one of the most important things we can do is to create a demand for more variety and choice in recycled products by purchasing them as often as we can.

By Kathleen McLean
Whenever possible, specify compact fluorescent lamps, which produce a warm light, use one-quarter to one-third the energy of incandescent lamps, and last 10 to 13 times as long. When designing exhibitions to travel, consider the energy consumption required to move them around the country, and try to keep their size and weight to a minimum.

### Design for energy efficiency

- **Use exhibition design to educate**
  Wear your environmental consciousness proudly. Acknowledge suppliers of recycled or recyclable materials, and let visitors know that you have chosen exhibition materials that save resources, include nontoxic materials, or can be reused and recycled. Provide outlets for visitors to return and recycle flyers and handouts. Invite suggestions for processes and materials that would help you do an even better job.

- **Kathleen McLean is director of the Center for Public Exhibition and Public Programs, The Exploratorium, San Francisco, California. This article is adapted from an appendix in her 1993 book Planning for People in Museum Exhibitions, published by ASTC. (Member price, $29; to order, call 202/783-7200 x140.)**
What’s Reasonable to Expect? Gauging Visitors’ Grasp of Conservation Messages

By Jeff Hayward

In the past decade or so, zoos, aquariums, and science and natural history museums have become more interested in delivering exhibition-based messages about environmental conservation. For various reasons, the interpretive goals for these exhibitions, as well as the expectations for their impact on visitor audiences, have sometimes been quite lofty. Perhaps the theory has been “We don’t want to ‘dumb down’ the messages, so why not teach by reaching high?” That way, after all, there’s the potential to lead visitors to a peak learning experience.

Although desirable, such epiphanies, in my experience, are rare. Having worked on 14 exhibitions with conservation messages at institutions of informal science education over the past decade, my staff and I sense some general findings about visitor attitudes toward environmental exhibitions and programs. As institutions plan new exhibitions, the following insights may help to create a context for expectations about conservation education.

• Visitors are receptive to conservation messages. People who come to your exhibition will pay attention to conservation messages, especially if they understand why the messages are important. (For example, “Save the dolphins” would be received well, but “Save the jellyfish” might appeal only to those already fascinated by jellies.) Ongoing evidence from the visiting public at museums, aquariums, and zoos suggests a low level of knowledge about ecology and conservation, but common awareness that humans have negative impacts on the environment. And it’s encouraging that 50 percent to 80 percent of visitors say they would like to know what they can do to help. Whether they actually change their behavior is another matter—and one that’s hard to measure well. We have seen people respond well to exhibitions that focus on environmental problems, as long as they can see some positives and some hope, not just all doom and gloom.

• Visitors’ interest in environmental issues varies. If you’re thinking of a “typical visitor” or an “average level” of interest, you will be missing this important point: Among visitors, there is a range of receptivity and interest in conservation. In our research, we have identified three audience segments:
  • people who are “active” in environmental concerns (typically 20 percent to 25 percent of the visitor audience)
  • people who are “sympathetic” to environmental issues but not active (about 50 percent to 65 percent of the audience), and
  • people who are “neutral” or “unconcerned” about environmental issues (roughly 15 percent to 25 percent of visitors).

We have also found a clear correlation with the amount of formal education: Visitors with more education tend to be more aware of, and receptive to, conservation messages. Some administrators and exhibit developers worry that conservation exhibitions may appeal primarily to those who are most interested (“preaching to the choir”). This situation is similar with other topics: Some people are interested in dinosaurs or contemporary art; others aren’t.

Although we want the whole world to change its behavior to help save the planet, it’s normal that the most likely outcomes will be to expand the knowledge and understanding of our most receptive audience, people with a preexisting interest in the subject.

• Visitors experience a range of outcomes: cognitive, affective, and behavioral. Inspired by the desire of our thoughtful clients to “have an impact,” we have been pursuing strategically important questions in exhibit evaluation studies: What are people getting out of conservation-related exhibitions? Who gets the main messages? How do they relate these messages to their everyday life? While describing quantitative and qualitative answers to these questions, we’re finding some strong results and some subtle ones—and a need to distinguish between types of outcomes.

Social scientists refer to different modes or types of experience. For example, some psychologists say the most fundamental dimension of experience is affect. If people don’t have any affective reaction, positive or negative, one wouldn’t expect much of a lasting impression. Regarding content, researchers talk about impacts in terms of potential growth in (1) awareness (making people aware of an issue or problem), (2) knowledge (concepts, relationships, decreasing misconceptions), (3) attitudes (a stable set of opinions, perspectives on an issue), and (4), finally, behavior (what people actually do).

Each of these levels of impact could be a worthwhile contribution of a conservation exhibition. But exhibit planners tend to want to have it all—difficult to achieve from a 20-minute leisure experience on a family outing.

(continued on page 15)
Changing Minds:
Learning Outcomes in Environmental Education

By Kirsten Ellenbogen, Martin Storksdieck, and Joe Heimlich

In recent years, discussion of learning outcomes for environmental education (EE) has largely been related to formal learning environments. In this article, we examine outcomes from three EE initiatives—a traveling exhibition on biodiversity, a partnership between a nature center and a school, and a water-conservation program in hotels—that were designed to be free-choice learning experiences.

Although each approached conservation issues differently and was aimed at different audiences, evaluation for all three encountered a common dilemma. The use of predefined learning outcomes as benchmarks for success did not fully capture the impact of the initiatives. Our learning outcomes were based on presumptions about who the participants were, as well as their interests, motivations, and agendas. The studies point to a need to move away from content knowledge results from exposure to the intervention?" and instead ask, "Which group of participants made what sorts of gains?" This shift requires a willingness to reconsider the suitability of learning outcomes for different audiences, and a broader understanding of learning that goes beyond content knowledge.

Biodiversity 911: Saving Life on Earth

Biodiversity 911: Saving Life on Earth, a traveling exhibition developed by the World Wildlife Foundation (and managed by ASTC), is designed to help people understand what biodiversity is, why it is declining, and how we can help to protect it. Summative evaluation of the exhibition—conducted in 2002–03 while it was at the National Geographic Society’s Explorers Hall, in Washington, D.C.—focused on visitors’ worldview and outlook (core values, beliefs, and ways of understanding and creating meaning), as well as understanding, attitudes, and attentiveness.

The evaluation consisted of entry and exit interviews and follow-up interviews conducted 3 to 6 months after the exhibition experience. There were three components to the interviews:

• All visitors were asked questions designed to assess their worldview and outlook, both in general and in relation to biodiversity. The interviews also included questions about agendas for visiting the museum and attentiveness to biodiversity issues.

• Half of the visitors completed a two-part card sort to capture (a) attitudes about biodiversity problems and (b) attitudes about roles and responsibilities in protecting biodiversity. The cards were designed to fit within three categories defined by previous research on conservation attitudes: (1) personal direct actions (e.g., "reduce my car use"); (2) personal passive actions (e.g., "donate money"); and (3) impersonal actions (e.g., "create tax incentives").

• Half of the visitors were asked to complete a Personal Meaning Map (PMM), a concept-mapping methodology that yields reliable quantitative results from a qualitative method of data collection. Visitors were given a blank piece of paper with "biodiversity" written in the center and asked to write words, ideas, thoughts, or images that came to mind. Initial responses provided a framework for an interview exploring biodiversity-related knowledge, interests, and experiences. The same visitors participated in a PMM interview on leaving the exhibition.

Whenever possible, the content of questions and card sorts was taken from national surveys, so assessment could be compared to U.S. norms. For example, surveys conducted by Belden, Russo-nello, and Stuart in 2002 had found that more than a third of the general public chose "personal responsibility" as the most important reason for caring about protecting the environment, followed closely by "respect God's work." In contrast, more than 50 percent of National Geographic visitors to Biodiversity 911 chose "personal responsibility," and less than 10 percent chose "respect God’s work." This was a group predisposed to learn about ways they could personally protect biodiversity.

One of the most interesting findings relates to visitors’ attitudes. Approximately 50 percent of Americans describe themselves as active in, or sympathetic to environmental issues. The audience at National Geographic surpassed this norm. The more critical issue, then, was the way in which they were active in environmental issues.

Before entering Biodiversity 911, visitors ranked impersonal actions as most effective in protecting biodiversity. After seeing the exhibition, visitors ranked personal direct actions as most effective. Specifically, there was a statistically significant increase in how visitors ranked "using pesticides," "reducing car use," and "eating more environmentally-friendly foods." Impersonal actions, such as "tax incentives," "tougher enforcement of anti-pollution laws," and "enforcing regulations" were ranked significantly lower after seeing the exhibition.
To prepare the student instructors, Irvine staff visit inner-city high schools to teach the approximately one-hour *Natural Connections* lessons, focusing on both content and delivery. The 9th to 12th graders subsequently teach the activities to younger students, focusing primarily on 3rd graders at a partner elementary school.

The impact of the *Natural Connections* program was assessed using pre- and post-surveys, observations, and teacher interviews. The focus of the evaluation was on the high school students who served as peer instructors. The stated goals of the program were “to increase students’ awareness of the natural environment, to nurture a positive attitude towards nature, to increase their knowledge about nature, and to provide teaching experiences that may influence students’ self-confidence and ability to teach.”

Turning the older students into instructors was a major mechanism to achieve these goals. Research shows that inner-city high school students tend to be unwilling to engage in natural settings novel to them and may exhibit limited receptivity to conservation messages that do not overlap with personal concerns. Thus, the program used peer teaching to engage students in subject matter they might otherwise reject.

Meeting program goals proved to be a challenge for two reasons. First, the outdoor activities were not embedded in a broader context of preparation or follow-up, so the same EE lessons did not satisfy the academic needs of both high school and elementary students. The second, and more important reason, was that teaching the younger students created a barrier to learning for the older students.

The high schoolers perceived their teaching as the major component of the program and were more worried about mastering the primary activity than mastering content. They saw great value in teaching and identified a range of program benefits related to teaching, rather than to learning about the natural environment. This focus on teaching was reinforced by data which revealed that students’ interest in the outdoors declined, and that there was no significant change in the students’ environmental attitudes and beliefs before and after participating in the program.

Until the high school students’ concerns about teaching and instructing are fully addressed, they will not be able to appreciate the academic content underlying the activities. Consequently, *Natural Connections* has shifted its emphasis for the high school students away from content and toward teaching. Future evaluation of the program will reveal whether increased support for teaching and instructing results in changes in knowledge and attitudes.

**Water Champs**

Our final example, though not directly related to museum education, focuses on a free-choice learning situation that has implications for institutions hoping to communicate their own conservation commitment to visitors.

In 2002, the Southwest Florida Water Management District conducted a study to determine how hotels’ water conservation was affected by hotel guests’ choosing not to have their linens and towels laundered daily. Hotels that encouraged their visitors to participate in the conservation initiative had a strong stake in determining awareness of the hotel’s role in decreasing overall water consumption. Since the “learning” desired was cumulative—increasing as the message of towel and linen reuse was repeated in multiple hotel stays—the challenge was to isolate the impact of the water conservation program of a particular hotel.

Evaluators used a short feedback form to determine guests’ awareness and perceptions of the value of the program. Most of the questions were
designated to assess guests’ awareness of the program (visibility, readability, clarity of information). However, some of the questions allowed comparisons with other environmental practices. There were also opportunities to provide comments. Finally, survey data were compared to actual water savings, in an attempt to understand guests’ role in hotel water conservation.

Visitors had an extremely positive response toward the hotels and the practice. They were satisfied with the hotels’ participation in the program. A small subset saw the activity as not meaningful or as an attempt by the facility to “look green.”

A strong minority noted that although they chose to participate, they believed the housekeeper did not pay attention to their request. Even so, 100 percent of the guests opted to reuse their linens, and 81 percent opted to reuse their towels. Furthermore, 98 percent of respondents said they believed these activities made a difference. Written comments reflected a range of underlying values, from appreciation of the hotel’s participation to admonishments as to what more the hotel (and other institutions) could and should be doing.

Conclusions

A focus on predefined learning outcomes would have missed much of the participants’ true experiences in these three studies. In the case of Biodiversity 911, an understanding of the audience as a voluntary, self-selecting group seeking experiences that reaffirm and articulate who they are, offers insight into possible goals for EE exhibitions. Although reinforcement of previously held knowledge, attitudes, skills, and beliefs is often derided as “preaching to the choir,” it is not only valid but also important for EE experiences to count identity building as a positive learning outcome.

In the case of Natural Connections, true outcomes for the high school students—including a heightened appreciation for teaching, increased teaching skills, and increased self-confidence—related more to their role as instructors than to increased content knowledge. Understanding the participants’ agenda helps to ensure that staff and students were not working toward mutually exclusive goals.

Finally, in Water Champs, we see that communicating conservation goals to people and engaging them in conservation practices may not satisfy the most knowledgeable of environmentalists, but it does create a positive impression of conservation in people’s minds and allows them to take a small, personal step toward preserving global resources. By giving people an easy alternative to act on, hotels were successful with all audiences, not just the most “attentive.”

Kirsten Ellenbogen and Martin Storksdieck are senior research associates at the Institute for Learning Innovation, Annapolis, Maryland; Joe Heinrich, an associate professor of environmental education at The Ohio State University, Columbus, is currently on sabbatical at the Institute. The authors wish to acknowledge Jill Gilmartin, Cheryl Kessler, Kathryn Wenitz, Judy Blau, Robyn Mofsowitz, Betty Olivolo, David Pragoff, Kristy Streett, and Melissa Rowe for their contribution to the work described in this article.

(Continued from page 12)

Defining standards for success

At this point in the field of visitor studies, we’re feeling our way regarding measurable outcomes. In general, measurement of impacts has to be put in context—i.e., related to the circumstances of an exhibition’s content. We were impressed, for example, when two-thirds of a substantial sample of visitors, interviewed one to two months after visiting a particular aquarium, recalled some specific piece of information they had retained about conservation. But it was just as useful that visitors described what they were recalling—since that could be tied to specific exhibits and interactive.

At another aquarium, where we were investigating the extent of people’s understanding of how each person or family affects aquatic life, we were disappointed to find (also one to two months after a visit) a statistically insignificant increase among the “active” environmental segment of the audience, and, unfortunately, a decrease among the “neutral/unconcerned” visitors in thinking they had any personal effect on aquatic life.

If you really feel the need for a benchmark, I would point to exhibitions where we’ve seen 60 percent to 65 percent of the visitors think that conservation was the main idea. (This was expressed in various ways, in their own words, in an exit interview.) That’s a very good level, in my opinion, especially when people’s attention is also drawn to live animals and immersive experiences that may not necessarily be perceived as a conservation concept.

A second way of defining a positive outcome is whether your visitors, as a result of seeing a particular exhibition, have thought about doing something differently after they go home. A reasonable benchmark in this area might be that 1 in 4 visitors has connected the exhibition content to his or her everyday behavior. If that 25 percent of your audience turns out to be the already “active” environmental supporters, that’s still not a bad result.

Of course, institutions would like some of their “sympathetic” or “unconcerned” visitors to be inspired and affected by an exhibition, too. But I think we should be cautious about holding ourselves to such extremely high expectations—as, for example, convincing neutral/unconcerned people that they should change their behaviors and lifestyles—that we overlook the realistic accomplishments.

Jeff Hayward is director of People, Places & Design Research, Northampton, Massachusetts.
Championing conservation in our own communities is an effective way to raise public awareness of environmental issues. In the three programs described here, ASTC members take a neighborhood approach to environmental education.

From Brownfield to Green Fields

By Donna Murray

Nearly three years ago, the Putnam Museum of History and Natural Science, in Davenport, Iowa, entered into an agreement with a local citizens action group and the City of Davenport to provide educational programming at the city’s Nahant Marsh Preserve.

The protected natural area includes more than 240 acres of wetlands, restored prairie, and riparian forest. River Action Inc.—the citizens group that works to promote “well-designed riverfront development, public access, and a healthy Mississippi River” in the Quad Cities area of Davenport and Bettendorf, Iowa, and Rock Island, Moline, and East Moline, Illinois—had procured grants and donations to cover three years of operations at the Nahant Marsh Educational Center.

Under the umbrella of its education department, the museum hired a naturalist to serve full-time at the preserve. Programming began in April 2001. In September 2002, a 900-hour Americorps position was added to support programming needs.

What made this project different from any other fledgling nature center was that, just a few years earlier, this urban wetland had been the site of a U.S. Environmental Protection Agency (EPA) Superfund cleanup.

For more than 20 years, a significant parcel of the land had been operated as a trap-and-skeet shooting club. In 1994, local conservation groups, concerned about possible contamination by lead shot, contacted the U.S. Fish and Wildlife Service. The next year, the gun club voluntarily ceased operations, and in 1997, Fish & Wildlife, after further testing the waterfowl and confirming contamination, contacted the EPA. The $2 million cleanup of the “brownfield” site—including excavation, treatment, and disposal of more than 140,000 tons of lead-contaminated sediment and soil—was completed in 1999, as part of the agency’s Five Star Restoration Program for wetlands.

At that time, the Nahant Marsh Steering Committee (a group comprised of representatives from city, state, and federal agencies and not-for-profit organizations) was formed to oversee the project and complete the reclamation. River Action, which continued to spearhead the effort, joined forces with the Iowa Natural Heritage Foundation to raise funds to purchase the gun club site, along with additional acreage.

In 2000, title was transferred to the City of Davenport. The Putnam Museum joined the committee in early 2001, as negotiations to provide educational programming at the preserve began. Today, Nahant Marsh is the largest urban wetland on the upper Mississippi River, and is the only EPA Superfund site that offers educational programming year-round.

At the Educational Center and through outreach programs, Nahant Marsh naturalist Jody Patterson engages elementary and secondary school students in exploration of wetland ecosystems, water quality, and biodiversity. Activities and events for the general public and organized groups are offered on a regular basis. One Friday a month, from April through August, the public is invited to join in a survey of frog and toad calls; after a brief training session, participants record observations to be included in ongoing research on the marsh’s anuran populations. The preserve’s trails and boardwalk are accessible throughout the year.

Undergraduate and graduate students from Western Illinois University and St. Ambrose University perform research and field-study assignments at Nahant Marsh. Current projects include a survey of turtle populations, a study that has confirmed the presence of the endangered Blanding’s...
turtle at the preserve. Four area colleges and two school districts are Nahant Marsh “Partners in Education,” supporting operation of the Educational Center through annual financial contributions. Students from these institutions attend on-site programs at no additional charge.

As we enter the final year of funding for the project, the Putnam Museum continues to explore avenues for operational support. Admissions and existing partnerships may be expected to cover 25 percent of costs, but grants and donations will be needed to continue the educational programming. River Action, along with other dedicated individuals and organizations in the community, has expressed a commitment to continue working with the museum to ensure the Educational Center’s success in the years to come.

Donna Murray is director of education at the Putnam Museum of History and Natural Science, Davenport, Iowa; www.putnam.org. For more information on the U.S. EPA’s wetlands restoration programs, visit www.epa.gov/owow/wetlands/restore/5star/.

My Backyard Habitat
By Cheryl D. McCallum

The PG&E EcoStation at the Children’s Museum of Houston (CMH) helps families understand and support the ecosystems local to their own backyards, neighborhoods, and/or city. The 2 1/2-year-old, 4,600-square-foot outdoor exhibition and its complementary programs reflect the interdependency of plants and animals common to the Houston area, along with ways that human influence affects them. Major funding for the project was provided by PG&E Corporation, with additional support from Houston foundations, corporations, garden clubs, and the district attorney’s office.

From any vantage point in the CMH courtyard, the EcoStation, with its lush native plantings and shallow pond surrounding an aged-cedar, houselike structure, draws people in. Passing through the almost transparent fencing around the exhibit, visitors are immediately immersed in a setting that any family would be happy to call their “backyard.” All EcoStation text is bilingual in Spanish and English, and exhibit components include

- a pond vibrant with lily pads, pickerelweed, mosquito fish, turtles, dragonfly larvae, and more.
- plants specifically chosen for their benefits to the Houston ecosystem, including many native and beneficial naturalized species.
- two Bayou Tables (Houston being the “Bayou City”), where visitors can experiment with ways that flowing water changes the landscape.
- seven activity stations where children can learn “outdoor skills,” such as recognizing animal tracks, judging the height of trees, and identifying plants and aquatic life.
- the Tree Stump Amphitheater, where families can participate in impromptu plays and puppet shows that reinforce understanding of the relationships between animals and their habitat.
- a 400-square-foot Research Pavilion that houses microscopes, an aquatic animal tank, weather instruments, a variety of displays, and a selection of more than 60 “Family Learning Boxes.”

Each of the Family Learning Boxes contains bilingual activity guides and all of the materials needed to explore the activity fully. In some cases, take-home materials are provided, so visitors can continue their explorations at home or in school. Museum educators are constantly revising and expanding the boxes. Recently added topics include “How Cold Is Too Cold?,” in which visitors collect and record weather data on how temperature influences animal activity levels, and “How Things Grow and Change,” which focuses on animal lifecycles.

All EcoStation activities align with Texas and U.S. curriculum standards. This association is emphasized in teacher materials and available for parents on request.

Development of EcoStation has been guided by a local nine-person advisory committee. Members include, among others, the program manager of the University of Houston’s

Lush native plantings and a houselike Research Pavilion add to the “backyard” atmosphere of EcoStation.

Photos courtesy Children’s Museum of Houston.
Environmental Institute of Houston, the coastal conservation education coordinator at the Nature Conservancy of Texas; and the executive director of the Council on Environmental Education.

Educators from the Environmental Institute, Texas Parks and Wildlife, and the Council for Environmental Education have used the exhibit as a base for teacher professional development workshops. During the 2002–2003 school year, seventh graders from a private school conducted a biodiversity study of EcoStation. CMH has worked with two national programs, Berkeley Botanical Garden’s Math in the Garden and Junior Master Gardeners, to pilot new curricula. Staff also provide trainings to teachers on the Lawrence Hall of Science PEACHES curriculum, which relates what they do in the classroom to what happens in EcoStation or in their own schoolyards/backyards.

Formative evaluations have informed many of the EcoStation enhancements. One of the evaluators’ reports includes a typical observation: “An 8-year-old boy was playing at ‘Go with the Flow’ for about 20 minutes when I heard him say, ‘Now I get it!’ When I asked him what he was talking about, he said he had been studying erosion in his science class and he never quite got it. After seeing what happened to the sand when the water was turned on, he made a connection to what he had done in class.”

A hallmark of EcoStation is the facilitation provided by Discovery Guide staff and CMH educators. This “people-to-people” learning is grounded in Vygotsky’s Zone of Proximal Development theory. Staff stationed in the exhibit full-time during public hours engage visitors in inquiry related to the phenomena of life and interactions in EcoStation, as well as in other outdoor settings in and around Houston.

These encourages of learning help visitors get to the next level of knowledge and exploration, and also help them make linkages from EcoStation learning back to their own neighborhood environments. Because the exhibit teens with animal and plant life, it is always easy for staff members to hook visitors into the special occurrence or focus of the day.

Cheryl McCallum is director of education at the Children’s Museum of Houston, Texas; the museum’s web site is www.cmhouston.org.

A Solar Solution
By Joaquin Fargas

The village of Bacoya, 12,000 feet high in the mountains of northwestern Argentina, does not appear on military maps. It takes three days to get there from Buenos Aires. For the last half day, there are no roads, or even paths. You must load your baggage onto mules and walk along a river bed to reach your destination.

But if you had made that journey on June 24, 2002, you would have encountered a most unusual sight—an entire village transformed into a solar energy workshop, with citizens young and old working alongside visiting science educators to electrify their school with solar panels, build their own solar toys, construct a greenhouse effect solar oven, and adapt their traditional recipes to a new style of cooking.

For a community that had previously relied on vanishing supplies of wood for heating and cooking, the moment was truly liberating. For the staff from Buenos Aires’ Centro Científico Tecnológico Interactivo Exploratorio (the Exploratorio), the day brought the satisfaction of helping both the people of Bacoya and their fragile environment.

Sunlight, of course, is everywhere, an inexhaustible source of energy. But we humans still intuitively utilize the most convenient and accessible resources at hand. In the case of energy, this usually means wood or oil.

Around the world, this practice has led to devastation of the environment. Many delicately balanced ecosystems have already been wiped out, and others are in grave danger of disappearing. In Argentina, the semi-arid highlands of the northern ecological systems are precariously balanced, and in the more heavily populated areas, urban sprawl has led to the destruction of forests.

Five years ago, the Exploratorio set up the program we call Mirando al futuro (“Eyes on the Future”). Its purpose is to promote awareness of the environmental and personal benefits of substituting solar energy for traditional energy sources. Not only does using the sun for power protect the land, but it also eliminates the necessity of gathering and carrying wood for cooking. Mirando al futuro was developed by professor Irene D’Amico, an expert in educational strategies, along with the author and four other Exploratorio specialists.

In 2000, we took our first solar ovens to communities in...
ecologically endangered areas of Argentina. Working out of a school or other community building, we would construct an oven with the locals and then teach them the new way of cooking. Together, we would figure out how to adapt vernacular recipes, traditionally cooked over wood fires, for preparation in a solar oven.

Over time the Mirando al futuro program has expanded to include solar-panel electrification and children’s activities. We have trained additional personnel to spread the program and help us achieve more significant results. Each community we visit elects a project leader who can oversee the construction of other solar ovens, using locally available materials, such as adobe bricks (made of a mixture of mud and hay) and llama wool for insulation.

Support for the program has come from Ciudadanía Solidaria, an nongovernmental organization that coordinates private sponsors; Fundación Capacitar del NOA, the power company of the province of Jujuy; the government of the province of Salta; and the congress of Salta, through Senator Sonia Escudero. Logistics have been handled by the National Police, which provides special vehicles for reaching remote communities.

To date, the results have been highly satisfactory, and a transfer of technology has been established. We have recently received funding from UNESCO to extend Mirando al futuro to Bolivia. And even though it is too soon to assess any environmental changes brought about by the program, we can say that it has improved people’s lives and changed the way they think about the environment.

Joaquín Fargas is executive director of Centro Científico Tecnológico Interactivo Exploratorio, Buenos Aires, Argentina. ASTC thanks Sergio de Régules of Universum, Mexico City, for his assistance in the preparation of this article.

**Calendar**

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<td>27–29</td>
<td>2003 ECSITE Annual Conference. “Sharing Ideas, Developing Skills, Building Networks.” Hosted by the Deutsches Museum, Munich, Germany, which celebrates its 100th anniversary this year. Details: <a href="http://www.ecsite.net">www.ecsite.net</a></td>
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<td>“Science Exhibits for the Youngest Visitor.” St Louis Science Center, St. Louis, Missouri.</td>
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<td>National Engineering Week (Canada) Details: <a href="http://www.new-sng.com">www.new-sng.com</a></td>
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* Information on ASTC RAP sessions is available at [www.astc.org/profdev/](http://www.astc.org/profdev/). For updated events listings, click on “Calendar” at [www.astc.org](http://www.astc.org).
TY/TE Summer Institute: Putting Brains to Work

Neurotransmitters. Dendrites. Synapse. Hippocampus. These are terms and concepts that 51 youth-program participants and their 17 adult leaders explored during the first Today’s Youth/Tomorrow’s Educators (TY/TE) Summer Institute, held July 28 to August 3, 2003. The weeklong pilot program was hosted by the Department of Biology at the University of Missouri–St. Louis (UMSL), with support from the St. Louis Center for Inquiry in Science Teaching and Learning.

TY/TE, which builds on the infrastructure and institutional capacity of the 10-year YouthALIVE! initiative, is a career-pipeline component of ASTC’s current Equity and Diversity Initiative. TY/TE is designed to address two critical societal needs: academic and career development support for underserved high school students, and the increasing need of science centers and schools for racially and ethnically diverse science educators who are skilled in working with children and families from economically and culturally diverse communities.

The youth who participated in the Institute already work at their local museums or science centers, performing demonstrations, assisting with classes, or explaining activities in after-school programs. Institutions attending included seven TY/TE pilot sites: Chabot Space & Science Center; the Lawrence Hall of Science; the Museum of Science (Boston); the New Jersey State Aquarium; the Science Museum of Minnesota; the Utah Museum of Natural History, and the local St. Louis Science Center. (All are continuing programs started under the YouthALIVE! initiative.) Funding for this year’s Institute was provided by a one-year grant from the American Honda Foundation, with contributions from Agilent Technologies, Rockwell, and the Wallace Readers’ Digest Fund.

The Institute curriculum consisted of five segments: science, teaching and learning, educational planning, careers in science education, and work skills development. To explore neuroscience, particularly the workings of the brain and its role in learning and some behaviors, the students participated in classes, hands-on demonstrations, labs (including dissection of a sheep’s brain), and workshops. One highly rated activity was the Brain Maze from Lawrence Hall of Science’s Learning About Science curriculum. Students engaged in complementary evening activities at the St. Louis Zoo and Missouri Botanic Gardens and attended a career fair featuring scientists, educators, and college students at the St. Louis Science Center.

Under the auspices of the Princeton Review, the youth took a practice ACT examination and received their scores, along with an analysis of areas that needed improvement. Based on presentations by staff from UMSL’s Office of Multicultural Relations/Academic Affairs, and with assistance from Institute staff, students developed education plans that mapped out directions for the remainder of their high school years. In their evaluations of the Institute, 70 percent of the youth indicated that this activity was either helpful or very helpful.

Student teams presented an activity from their home science center and received critical feedback from their peers, based on information from the sessions on the brain, teaching, and learning. At the conclusion of the Institute, teams shared plans for applying their newly acquired knowledge and skills in their home institutions.

ASTC and the TY/TE sites will reinforce, complement, and enhance the work introduced at the Institute throughout this school year. If funding is available, we will conduct a 2004 TY/TE Summer Institute for teams from eight new sites. Any ASTC-member institution that is actively participating in one of the regional youth program networks and has a strong, work-based youth program engaging underserved high school students will be eligible for consideration.

For further information, or to learn more about the TY/TE Initiative, contact Jacquelyn Lowery, (202) 783-7200 x139; jlowery@astc.org.

Frontiers of Science in Japan

ASTC and the science center community were well represented at the Third U.S.-Japan Conference on the Public Understanding of Research, sponsored by the National Science Foundation and the Japan Science and Technology Corporation, and held July 10–20, 2003, in Tokyo. The host for the conference was a new ASTC member, MeSci, the National Museum of Emerging Science and Innovation (see “Welcome to ASTC”). MeSci director Mamoru Mohri, Japan’s first astronaut, gave the closing keynote.

U.S. delegates included ASTC president Walter R. T. Witschey, of the Science Museum of Virginia; Dave Chittenden, of the Science Museum of Minnesota (SMM); and Rob Semper, of the Exploratorium. Walter submitted the following report:

“We were accompanied by Ed Fry, who is developing DiscoveryStation for the campus of Texas A&M University. Besides attending sessions, we had the opportunity to tour notable Japanese installations for large-scale science, as well as several science centers in the Tokyo and Kyoto areas.

“All participants were struck by the
extent to which big science has become international in both research in reach—especially the number of international researchers submitting projects to Japan’s Earth Simulator Computer Center (currently the world’s fastest computer) and the full integration of components from many countries (including a Japanese module) into the International Space Station.

“Many conference attendees expressed an interest in working more closely with science centers and the media on public understanding of research, and SMM and MeSci executed a memorandum of understanding for a collaborative project.”

For further information, contact Hyman Field, Senior Advisor for Public Understanding of Research at NSF; hfield@nsf.gov.

Going “Green” in St. Paul

If you’re headed for ASTC 2003, this year’s program highlights a variety of approaches to raising environmental awareness.

A preconference day trip to Headwaters Science Center, in Bemidji, Minnesota, on Thursday, November 6, will let participants see how a small, community-based science center works to support public understanding of environmental issues. A Friday tour, “The Mississippi River in the Twin Cities,” takes participants behind the scenes at the University of Minnesota’s National Center for Earth-surface Dynamics (NCED), a research site devoted to the responsible use of landscape and seascape resources.

On Saturday, November 8, two featured speakers known for their commitment to environmental issues will offer their artful interpretations of nature. Award-winning photographer/writer (and native Minnesotan) Jim Brandenburg will share his images and describe his efforts in helping to restore the Northern Tallgrass Prairie. California musician and bio-acoustician Bernie Krause, whose albums integrating sounds both wild and designed into musical compositions are international best-sellers, will share his experiences in “discovering the voice of the natural world.”

Three concurrent sessions also touch on environmental topics. Watch for the following in your conference program:

- Environmental Outreach: When Small Centers Get (Relatively) Big Money. Session leader: Adela (Laddie) Elwell, Executive Director, Headwaters Science Center
- Considering Biodiversity: Effective Education and Evaluation Approaches. Session leader: Ellen Giusti, Coordinator of Exhibition Evaluation, American Museum of Natural History

Correction

In our September/October issue, one RAP-sponsoring institution was inadvertently omitted from the table of 2001–2003 ASTC RAPs. “Science Discovery Rooms That Work” was hosted by the Sciencenter, Ithaca, New York, in June 2003. Participants included 27 registrants and 4 staff members. We regret the error.
Focus on Conservation


Visitors to Explorers Crossing encounter an environmentally friendly “village” complete with a scaled-down general store, town hall/courthouse, animal hospital, garage, recycling center, and landfill. Through creative role play, they learn to make smart environmental choices as they go shopping, consider issues of environmental law and animal rights, care for animal “patients,” and do eco-friendly auto maintenance.

Prototypes for the store, courthouse, and animal hospital came from two popular Boonshoft exhibitions, the 2000 Kids Town and the 2001 Kidsville. In the new Recycling Center, visitors can sort through “trash” to identify four easily recyclable materials. When these are deposited into the correct game machine, the visitor receives a take-along collectible card that tells more about the benefits of recycling.

In the landfill area, children can operate the controls of an excavator and load trash onto a truck bed for delivery to the landfill. Inside the mound, visitors learn about the rates of decomposition for many common items. Who knew, for example, that a glass bottle buried in a landfill will take longer to decompose than the Statue of Liberty?

Of course, not everything can be recycled or reused. The “Legacy of Waste” wall tells about ways trash has been handled through the ages and discusses modern alternatives.

Explorers Crossing is a collaboration between the museum and the Montgomery County Solid Waste District, with funds provided by the Board of County Commissioners’ solid-waste outreach and education programs. Additional support came from Porter, Wright, Morris, and Arthur LLP, and from NCR and Liberty Bank.

Details: Cathi Eastman, ceastman@boonshoftmuseum.org

GREATER THAN MOST—The five North American Great Lakes (Erie, Huron, Michigan, Ontario, and Superior) and their connected waterways stretch for more than 1,100 miles along the U.S.-Canadian border. This vast system, which contains 18 percent of the world’s fresh water, is subject to increasing environmental pollution and ecological stress, but public awareness of those threats—and efforts to remediate them—remains low.

The Great Lakes Story, a new traveling exhibition from the Great Lakes Science Center (GLSC)—itself located on the shores of Lake Erie in Cleveland, Ohio—aims to fill this information gap. The 3,000-square-foot traveling exhibition, which owes much to GLSC’s 10,000-square-foot permanent Great Lakes Environment Exhibition, includes a 10-foot-by-12-foot, interactive walk-around map of the Great Lakes Basin, plus 24 hands-on exhibits staged within four main areas: Why the Great Lakes Are Great, Great Lakes Natural Processes, Changes and Threats to the Great Lakes, and Restoring the Great Lakes.

Visitors can learn about the physical characteristics, geography, and geology of the region and explore ecosystems, food webs, and the cycles of air, water, and soil. They can develop new understanding of challenges like endangered and exotic species, climate change, and biomagnification. Finally, they can learn about efforts to renew the Lakes and “vote” on Great Lakes debates. Programming includes curriculum guides and pre- and postvisit materials for grades 2–12.

The Great Lakes Story was designed by ZMA Inc.; exhibits were fabricated by Design Craftsmen. Major funding was provided by the National Science Foundation, with additional support from the State of Ohio and the Perkins Charitable Foundation.

Details: Val Davillier, 216/696–4860, davillierv@glsc.org; www.glsc.org

THE WEB OF LIFE—Biological diversity, or biodiversity, encompasses the total variety of life on Earth, from genes to species to ecosystems. In a new public program, The Year of Biodiversity and Conservation, Chicago’s Field Museum highlights its biodiversity research worldwide.

The program, which actually runs from September 2003 through May 2004, features a different theme and museum scientist each month. Lectures, show-and-tell sessions, and roundtable discussions allow visitors to learn how scientists are assessing the global status of biodiversity and working to conserve threatened habitats and species. Hands-on family workshops and behind-the-scenes tours of the museum’s collections provide deeper exploration of the different themes.

Among the topics scheduled are climate change, freshwater and ocean ecosystems, backyard biodiversity, and plant and animal life in equatorial areas of Africa, Asia, and Latin America. One month focused on genetic research in the on-site Pritzker Laboratory for Molecular Systematics and Evolution. The year will conclude with a look at how Field Museum scientists are helping to reconstruct a family tree of all of Earth’s plant and animal species.

Complementing the live events are temporary exhibitions, such as a photographic portrait of Madagascar, and a web site with more in-depth information and a Take Action! section for residents of the Chicago area. Support for The Year of Biodiversity and Conservation came from the City of Chicago Department of Environment.

Details: www.fieldmuseum.org/biodiversity/
The California Science Center, Los Angeles, has received the largest single gift in the institution’s history. The $25 million pledge from the Annenberg Foundation in support of the science center’s Master Plan and Phase II expansion is positioned as a challenge grant, to be matched dollar-for-dollar from other private and public sources. The gift brings to $31 million the total given by the Annenberg Foundation to the expansion project.

The Challenger Center for Space Education, Alexandria, Virginia, was awarded $39,000 by NEC Foundation of America to support the development of technology education to assist children and adults with disabilities.

The Bishop Museum, Honolulu, Hawaii, has received an unrestricted charitable remainder trust of approximately $18 million from the estate of real estate heiress Maude Woods Wodehouse. The money will be used to endow the museum.

The Science Museum of Minnesota has received $550,000 from the Bush Foundation, St. Paul, to implement a museum-wide program focused on public understanding of current science.

Two ASTC members have received 2003 National Leadership Grants for Museums in the Community from the Institute for Museum and Library Services, Washington, D.C. The Children’s Museum, Boston, was awarded $499,840 for Making Connections for School Readiness, and the New Mexico Museum of Natural History and Science, Albuquerque, received $249,923 for the Proyecto Futuro bilingual partnership. Both grants require recipient matches. For more information, visit www.imls.gov.

**Grants & Awards**

**A NEW PLACE IN THE PARK—**

After celebrating its 150th birthday in 2003, California’s oldest museum will close its doors on December 31—but only temporarily. San Francisco’s California Academy of Sciences will return to its Golden Gate Park site in 2008 as a model of sustainable design. In the meantime, visitors can continue to experience natural history exhibits and view most of the Aquarium’s animals in temporary quarters downtown.

The new Academy, one of 10 pilot projects in the city’s “Green Building Program,” will showcase renewable energy generation, water efficiency, and environmentally friendly materials. Architects Renzo Piano and Gordon H. Chong and Partners have created a village-like cluster of spaces under a contoured “living roof” that echoes the rolling hills of California. Planted with grasses and groundcovers, the roof will reduce energy costs, lower ambient temperatures, and keep some 2 million gallons of rainwater a year from carrying pollutants into nearby ecosystems.

The use of natural materials and low building heights, plus the nearly three acres of newly created green space (the project has a smaller footprint than the current museum) will help the facility blend more naturally into the park. Central to the design is a partially enclosed piazza planted with native California trees.

Rocky Mountain Institute founder Amory Lovins is helping to design sustainable exhibits and operational strategies for the 95,000 square feet of public space. Existing elements like Africa Hall and the barrel-vaulted ceiling of the Steinhart Aquarium will be integrated with new exhibits to reflect the complexity of the living world. New galleries will include a rain-forest exhibit, a 225,000-gallon Philippine coral reef habitat, and a Naturalist Center.

San Francisco voters have approved $115 million in bonds for the new building, and the Academy has initiated a $150 million capital campaign toward completion of the project.

**Details:** Pat Kilduff, pkilduff@calacademy.org; www.calacademy.org

**FRESHWATER FOCUS—**

2003 is the United Nations Year of Freshwater, and Pier Wisconsin, located in a former ferry terminal on the shores of Lake Michigan in Milwaukee, is working to encourage greater involvement in freshwater issues by community stakeholders and citizens.

Although the science center’s new $30 million facility will not open for several years, staff are already providing a variety of educational programs. One initiative, Voyage of Discovery, brings to life the dynamics of research on rivers, lakes, wetlands, and the oceans.

The heart of the program is the S/V Denis Sullivan, the museum’s 138-foot replica of a traditional three-masted Great Lakes schooner. This research vessel plies the Lakes in summer and spends the winter in the Caribbean doing “science-under sail” projects, including mapping ocean currents, studying reef and benthic ecosystems, and analyzing estuarine and marine pollution. High school students who join the missions participate actively as both researchers and crew.

At least once a month, the scientists and students on the Sullivan broadcast live, interactive programs back to the center and participating classrooms. Interactive web pages (accessed through www.piervisconsin.org) and kiosks at partner sites round out the program.

Funding for the $1.5 million initiative was provided in part by a $700,000 Technology Opportunities Program grant from the U.S. Department of Commerce’s National Telecommunications and Information Administration.

**Details:** Rolf Johnson, rjohnson@piervisconsin.org

**The Great Lakes schooner S/V Denis Sullivan, research vessel of Pier Wisconsin, heads out on a scientific mission. Photo by Chris Hamm**
In honor of his accomplishments in physics and oceanography, D. James Baker, president and CEO of the Academy of Natural Sciences, Philadelphia, has been elected to the American Philosophical Society. Founded by Benjamin Franklin in 1743, the nation’s oldest learned society, which includes more than 700 distinguished members worldwide, works to promote excellence and useful knowledge in the sciences and humanities through scholarly research, professional meetings, publications, library resources, and public exhibits.

The new director of the Informal Education Division of NASA’s Office of Education is James Stofan. A former senior vice president for education programs at the National Wildlife Federation, Stofan will oversee the development of new partnerships and work to improve the capacity of science centers, museums, and other institutions to translate and deliver NASA content.

The Omaha Children’s Museum announces two appointments: Joining the museum as director of communications is Kate Cavannagh, a former journalism professor and longtime museum volunteer who was most recently a columnist for the Omaha World-Herald. Richard W. DenHerder is the new director of finance and operations at OCM; he was previously interim CEO of Omaha’s Open Door Mission.

Four ASTC-member directors were among the new board members and officers elected by the American Association of Museums (AAM) at the organization’s annual meeting in May. Serving as AAM Vice Chair for the 2003–2004 term is Jeffrey N. Rudolph, president of the California Science Center, Los Angeles. Elected to three-year member-at-large positions (2003–2006) were Kate Bennett, president of the Rochester Museum & Science Center, Rochester, New York; James C. McNutt, president and executive director of the Witte Museum, San Antonio, Texas; and Dennis Wint, president and CEO of the Franklin Institute, Philadelphia.

The new director of Roper Mountain Science Center, Greenville, South Carolina, is Bill Bradshaw. Formerly executive director of the Museum of Discovery, Little Rock, Arkansas, Bradshaw replaces Darrell W. Harrison, who retired in December 2002 after 17 years with the science center.

ASTC and the Oregon Museum of Science and Industry (OMSI), Portland, mourn the death of Loren D. McKinley, executive director of OMSI from 1960 to 1978 and a member of the museum’s board from 1995 to 2001. A driving force behind OMSI’s expansion and growth, McKinley was also the first president of ASTC. He died on August 29 at the age of 83.