Working at Play: Informal Science Education on Museum Playgrounds

JANE CLARK CHERMAYEFF, ROBERT J. BLANDFORD, AND CAROL M. LOSOS[·]

Abstract

This article discusses the importance of play in informal science education and the growth of science playgrounds as an international trend among museums to create safe, challenging outdoor environments that use play to explore the foundations of science.

Play is characterized by intrinsic motivation, active engagement, attention to means rather than ends, non-literal behavior, and freedom from external rules, a means for acquiring information about and experiencing the environment. Successful exhibitions for children and families share these qualities and outdoor exhibitions encourage a degree of exploration and full-body experience often not possible nor appropriate inside a museum.

Two case studies are provided as evidence of the importance of play in the interpretation and design of science playgrounds. The first, *Science Playground* at the New York Hall of Science (opened 1997), uses an interpretive strategy in which evaluation and remediation are continually incorporated into the educational process. Experimental workshops were conducted to observe children's intuitive uses of the physics-based exhibits, uninhibited by any authoritative explanations. From this evaluation, the institution elected not to produce interpretive signage at each unit, but rather to develop a guide for visitors and one for educators that outline the exhibition's basic physics principles and encourage visitors to experiment and make connection to their own experiences

The second case study, *Exploration Park* at Prisma, Zona Exploratoria de Puerto Rico in San Juan (opening 2002), outlines ten design criteria used to develop the playground. These include bringing together a diverse team to respond to institutional and audience needs, ages, interests, and cultural backgrounds; creating a specific sense of place, making use of the local environment and taking advantage of natural elements including water, soil, wind, and sun. Practical considerations of safety, materials, and testing and prototyping are also addressed.

The article concludes with the idea of play as essential not only in child development, but also in development of successful outdoor science exhibitions.

[·] Jane Clark Chermayeff *is a member of The Museum Group and principal of Jane Clark Chermayeff Associates LLC, Program and Exhibition Planning and Development (JCCA)* <jcc@jcca-nyc.com>. Robert J. Blandford *is senior associate* and Carol M. Losos *is an associate at JCCA, 432 East 91st Street, New York, NY 10128*, <info@jcca-nyc.com>.

INTRODUCTION

Children are experts at play. Play is how children interact with others and experience the world around them. Play is experimenting, cooperating, observing, taking risks, achieving success, learning from failure and, of course, having fun. While play is essential to the physical and emotional growth of children, it is also central to adult social interactions and continued development throughout life. Yet despite the importance of play, it is increasingly de-emphasized in children's lives as recess is abolished, homework increases, and organized activities abound. Some adults deride play as frivolous and non-essential in favor of more structured academic endeavors. Real free time among children ages twelve and under declined from 40 percent of a child's day in 1981 to 25 percent in 1997 (Hofferth and Sandberg 1997). Further, present-day parents often perceive unsupervised outdoor settings as threats to their child's safety.

Museums are poised to serve children and their communities by creating outdoor exhibitions that harness the power of play. Play is characterized by intrinsic motivation, active engagement, attention to means rather than ends, non-literal behavior, and freedom from external rules (Van Hoorn et al. 1999). Jerome Bruner (1972) described play as a means for acquiring information about and experiencing the environment. In his view, play provides opportunities for children to try new combinations of behaviors and to master routines that make later observational learning possible (Diamond 1996).

Successful exhibitions for children and family audiences share these qualities. Like play, they are experiential and child-directed. They encourage children to ask questions, experiment and make connections to their own lives. Recently, many science centers and children's museums have begun to develop outdoor spaces that include science playgrounds. These popular outdoor exhibitions reinforce the process of scientific discovery described in the National Science Education Standards: "*…background knowledge and theories guide the design of investigations. In turn, the experiments and investigations students conduct become experiences that shape and modify their background knowledge*" (National Academy of Sciences 1995, p. 143). As learning environments, science playgrounds take advantage of the familiar vernacular of a playground to create alternative pathways to informal science in the community, the classroom and at home.

Our challenge as curators, exhibit developers, and designers is to create museum environments that support children's natural instincts to explore, discover, experiment, have fun and learn. In this article, we look at two case studies of the growing phenomenon of outdoor science playgrounds at museums worldwide. An interpretive strategy is examined in the first case study, the *Science Playground* at the New York Hall of Science, Flushing Meadows-Corona Park, New York. Design considerations are enumerated and addressed in the second case study, the development of *Exploration Park* at Prisma, Zona Exploratoria de Puerto Rico, San Juan. In conclusion, we explicate the questions that curators and designers must address in the on-going development and expansion of museum playgrounds.

Museums and Science Playgrounds

The growth of science playgrounds (also called parks or gardens) reflects an international trend among museums to create safe, challenging educational environments that use play to explore the foundations of science. This concept was pioneered in the 1970s by the Vikram A. Sarabhai Community Science Center, a small science museum in Ahmedabad, India. Participatory science demonstrations about human perception, simple machines, and other physics principles were placed in the outdoor space surrounding the Center. Since then, the National Council of Science Museums of India has developed more than 150 outdoor science exhibits for parks throughout India <www.ncsm.org>. Museums around the world, including Israel's Weizmann Institute of Science; the Tsukuba Science Expo Children's Plaza (Japan); Science Center (Ithaca, NY), the St. Louis Science Center; SciTech (Aurora, Il); and The Franklin Institute Science Museum (Philadelphia, PA), have opened science playgrounds. Others are currently being developed by museums in San Sebastian, Spain; Montshire, Vermont; Sausalito and San Francisco, California.

Exhibitions—and visitors—work differently outdoors than they do indoors. Like their indoor counterparts, science playgrounds promote "minds-on" exploration, experimentation and analysis through interactive components and complementary interpretation. Exhibits are designed to illuminate specific fundamental scientific principles, frequently mechanical, optical, and aural. On-site educators, labels, publications, and programming assist children in moving from experiential exploration to an analytical understanding of the properties at work. Children at these playgrounds become young scientists investigating the world around them.

To consider what makes learning in an outdoor museum environment unique, and to explore ideas for an outdoor exhibition at its site, the Exploratorium (San Francisco) convened an international team of educators, exhibition developers, museum directors, and architects in 1999. At the conclusion of the two-day workshop, landscape architect Robin Moore observed, "*What I think is going on outdoors is that children feel more comfortable and playful, which leads to intrinsic engagement*" (Exploratorium 1999:15). When children arrive at a science park they are already experts in play and playgrounds. They know what to do: slide, splash, climb, and crawl. They come ready to play and, in the proper context, primed to learn. They have the freedom to choose, experiment, and explore, as well as to swing, jump, and be noisy.

Another participant, Alan Friedman, director of the New York Hall of Science, commented that when exhibits are outdoors people approach the experience expecting it to be real, so that the amount of time they are willing to spend is often greater and they make more connections to the real world (Exploratorium 1999).

Science playgrounds encourage a degree of movement, noise, and full-body experiences often not possible or appropriate inside a museum. They provide opportunities to create large-scale environments that take advantage of the landscape and naturally occurring properties such as solar power and wind energy. By working outdoors children build a vocabulary of routines and experiences that relate to and enhance their understanding of their everyday physical world. These are the foundations for later learning, as described by Bruner (1972). Children connect the play on a giant see-saw, the movement of a large lever, or the turn of an Archimedes screw (all simple machines) to the work at a neighborhood construction site. Indeed, site observations suggest that play activities like these not only promote scientific learning, but also engender lifelong learning skills such as experimentation and teamwork.

Science playgrounds seem to match all the qualities of the best of leisure; visitors rate leisure to be at its best when the freedom to participate is high, the activity is intrinsically motivated, and the activity is engaged in for its own value, rather than to achieve another goal (Neulinger 1974 cited in Hood 1993). Science playgrounds are comfortable places in an often-imposing setting. Large, bold, fun and, most importantly, familiar, a science playground invites the community to enter, play and explore. Attracted by an outdoor exhibition, new visitors may continue their visit inside. Attendance at the New York Hall of Science, for example, doubled during the *Science Playground's* first season, and has continued to expand each year.

Case Study 1:

Interpretive Strategy for the *Science Playground,* New York Hall of Science, Flushing Meadows-Corona Park, New York

Opened in 1997, the *Science Playground* at the New York Hall of Science is a 30,000 square foot, three-tiered, outdoor laboratory with over three dozen physics-based exhibits. Interactive components include:

- a 200-foot-long waterworks with Archimedes' screws,
- waterwheels, and other kid-powered units that control the flow and movement of water,
- slides—one straight, one a catenary curve;
- the Spider Web, a 20-foot tall climbing net that accommodates dozens of kids simultaneously;
- the Energy Wave;
- solar-powered sun catchers, and
- a giant seesaw where one child can counterbalance an entire class.

The playground was developed for children aged 6-12, and was designed to accommodate school groups as well as family visitors.

The goals of the *Science Playground* were to:

- heighten awareness of the elements and forces of nature, and of the technologies that make use of them;
- provide a group of activities which can be experienced and interpreted in a variety of ways by a diverse group of users;

- create exhibits that children can interact with in ways that develop direct physical knowledge and encourage cooperative play; and
- attract new and repeat visitors to the New York Hall of Science with high-profile and well-designed exhibitions.

The *Science Playground* development team was committed to creating a model science playground, and incorporated evaluation and remediation into the design process. Prior to installation, all of the stainless steel water exhibits were tested for play value, safety, and durability. The units were prototyped at the headquarters of the manufacturer, Richter Spielgeräte GmbH, in Frasdorf, Germany. There, children tested the equipment on a village playground for periods ranging from three weeks to four months. Adjustments were made to both improve mechanical operation and increase play value. For example, after children were observed struggling to move water up the Archimedes screw to fill the upper bucket and get the playful payoff of a huge spill and splash, the channels on the screw were deepened, allowing more water to be carried to the top faster.

Most of the equipment was installed six months prior to opening, providing an opportunity to test the exhibits with New York City users. One area proved not durable enough for daily use and was replaced. One water activity was designed to be foot-powered, but had to be retrofitted with a hand crank. The later instance raised the question of why American children had difficulty with this component while the German children did not. Analysis revealed that the German children visited the pilot playground many times, learning from their mistakes and perfecting their use of the equipment. Visiting just once and for a limited time, the Hall of Science audience did not have the advantage of this learning curve.

With some exhibit modifications completed and others underway, the *Science Playground* opened. However, the funds for interpretive signage were not yet available, so the playground opened initially without interpretive signage. This deficit provided the team with an opportunity during the first season to observe and ask critical questions: How were the visitors using the playground? What were they learning? What kind of interpretive framework and collateral materials would best augment, support, and promote learning for the diverse visitors?

The interpretive strategy was developed through a collaborative process. In the summer of 1998, a select group of scientists, New York City fifth-grade students, their teachers, museum staff, and the museum’s explainers (high school and college student interpreters) were invited to envision the most effective educational experiences for visitors to the playground. The scientists, teachers, and children used the *Science Playground* while the interpretive consultants and explainers observed and documented their interactions. This working session, particularly the children’s words and ideas, provided the foundation for the development of interpretive materials and staff training. In addition, the scientists served as model facilitators for the museum’s young explainers, offering creative techniques for engaging the visitors in playground physics.

Over two hundred fifth-graders and their teachers participated. The children’s science backgrounds were diverse. For some of the students the *Science Playground* was their initial exposure to physics. Others had engaged in previous physics investigations outdoors and in the classroom. Some had studied related units at school, prepared for the visit, and were veterans of museum field trips; others had little or no classroom experience in physics or preparation for this particular visit. Not surprisingly, their responses were equally varied. While all children became actively engaged with the *Science Playground* exhibits, not all could verbalize the experiences. Scientist and educator Phyllis Morrison helped the team reconsider how to evaluate success. She said, *“Look at those kids and just observe how these fifth graders are using space. If they were bored, they would be sitting on the lawn and you would not have done a good job of designing a science playground. They’re absorbed and collaborating with each other—you’re where you want to be.”* (Morrison per. comm.)-

For each exhibit component, responses of the participants were compiled into three categories: "Best Kids' Comments," collected while the students used the exhibits, offered insight into the relevant connections made by the students. "Best Leading Questions," posed to students by the master scientists, staff, and explainers, helped uncover where children’s intuitive understanding required additional explanation by teachers or parents. "Comments and Recommendations," proposed by the team were used to guide the development of interpretive materials and made connections to other activities throughout the Hall of Science. Following are workshop excerpts regarding two exhibits exploring wave action: the Energy Wave and the Spider Web.

The Energy Wave

Best Kids' Comments:

- It channels the energy through the balls.
- It's like an echo.
- It's a chain reaction.

Best Leading Questions:

- Try to make the biggest wave? (team action)
- Can you send down a continuous wave?
- If you slosh in the bathtub does something look like this?

Team Comments and Recommendations:

- Use demo experiments: spaghetti and string, telephone cord.
- Clap hands to create a visible "echo."

The Spider Web

Best Kids' Comments:

- Shake it!
- Vibration is like a message.
- Everything is connected together.
- It's like a spider web.

Best Leading Questions:

- If a spider were at the top and you started to climb, would it know you were there? How?
- When you sit in different spots on the web and others move, who moves most? Least? Why?
- What is it like when you are climbing?

Team Comments and Recommendations:

- Limit the number of kids to maximize the experience.

- Make connections to the other wave action experiments in the playground such as the speaking tube, gong and wave-water machine.
- Make connections to the live spider exhibit inside the museum.

The workshops confirmed that interpretive strategies for outdoor play exhibits should be multi-leveled to welcome diverse responses, and child-directed so that each child actively takes part in the interpretive process in his or her own unique way. The *Science Playground* also provides adults with an unusual opportunity to observe the competence, prior knowledge, and experimental approach of children at play. Indeed, one teacher commented how surprised she was to learn the depth of her students' existing knowledge of hydraulic energy. In their active play the children revealed more about their understanding of the physical environment than they were able to verbalize or represent abstractly. To be intrinsically engaged with the exhibit, children do not have to be asserting scientific observations and hypotheses.

The workshops reinforced the museum director's observation on the significance of the informal science learning that takes place as children explore outdoors. Kid's comments about the 12-foot Archimedes screw such as "*the water at the top of the screw is stored energy, just waiting to make the machines work*," or "*it's like a drill*" are two examples. The resulting interpretive strategy was an active process, based on scientific inquiry and the National Science Education Standards concept that learning science is something that students do, not something that is done to them.

The importance of the explainers was reinforced by the workshops, as illustrated in the "Best Leading Questions." Working with the scientists, who modeled behavior and encouraged questions, explainers became more familiar and comfortable with the exhibition. They learned not to interrupt the children's play, to play with and support the children, and not to lecture. Instead of leading the children, they began to listen carefully, respond to questions, suggest pathways, and most importantly, pose challenging questions of the young visitors while also encouraging older family members to participate. Explainers held discussions about various theories of play and their application to interpreting the science playground. One rule, adapted from Wasserman (2000), holds that the first rule in formulating questions for children regarding play is to carefully observe the child's behavior and words. A second principle is to respect the child's attentions and autonomy. Or, in other words, do not pass judgment on their play

The decision not to produce interpretive signage at each unit as originally planned was another key result. Morrison reminded us: *"Look at those kids, do they look like they need to be told what to do? They are engaged…. By not putting extensive signage out here it is saying—in a very significant way—it is okay to just explore."* (Chermayeff 1998, 9).

Recognizing that that certain audiences sought more information about the playground exhibits, the Hall of Science created *Welcome to the Science Playground*, a visitors' guide for parents and caregivers that asks questions, encourages experimentation, and creates connections between exhibits and the phenomena of everyday life. An *Educators' Guide,* sent to classroom teachers and group leaders prior to their visit, suggests additional collaborative experiments on the playground and in the classroom. Both guides outline the five "Big Ideas" of physics explored through the exhibits: reflection and waves, action-reaction, energy and its transformations, sound, and simple machines.

In the visitors' guide each exhibit unit is listed under its "Big Idea" with two sections of text: "To Do and Notice" and "What's Happening." The fifth grader's language, questions and ideas are quoted (*One person can make a difference!*), and the text frequently refers to real-world comparisons. The "What's Happening" descriptions of scientific principles offers support material for adults. The brochure concludes with "Home Lab Activities" that can be performed with items commonly found around the house. Following is an excerpt from the visitors' guide.

Welcome to the Science Playground

As much as possible let your children guide you through the exhibits and explore independently. Then use the information in this guide to help them draw connections among their different experiences

Giant Seesaw

To Do and Notice: You can make a difference!

The weight of the Giant Seesaw's platform is perfectly balanced on its central pivot or fulcrum.
Try walking across the platform from end to end.
How does your weight at either end of the platform affect its balance?
Along with some friends, try to find a new balance.
How can you upset that balance?
Have your friends stand on one side of the central pivot or fulcrum.
How can you position yourself to be able to lift your friends?
One person can make a difference!

What's Happening?

The Seesaw is an example of the simple machine called a lever. Simple machines make doing work easier. The further from the fulcrum you are, the bigger an impact your body has on the whole seesaw. A small force (your weight) far from the fulcrum can balance a much larger force (the weight of your friends) if it is nearer to the fulcrum. In other words, a small force from you over a large distance is equal to a large outcome force over a small distance.

HomeLab Activity

Conduct a simple machine scavenger hunt in your home or school. How many pulleys, wheels and axles, wedges, ramps and screws can you find?

The experiences at the *Science Playground* are building blocks for further scientific discovery and analysis back at school and home. Children at the exhibit were already making connections to their everyday lives. Kids' comments on various experiences included observations such as: "*It's like when you spin on ice skates,*" "*it works like the phone lines,*" and, "*I think it works like the solar panels on a house.*" Ongoing evaluation and development of new interpretive exhibits and programs continue to help the New York Hall of Science increase the impact and effectiveness of the *Science Playground*. Plans are now underway to develop an area of the playground dedicated to visitors ages five and under.

Case Study 2:

Design of *Exploration Park*, Prisma, Zona Exploratoria de Puerto Rico, San Juan

Exploration Park at Prisma, Zona Exploratoria de Puerto Rico is the first phase of a proposed seven-acre children's campus, part of a new convention center district near Old San Juan, Puerto Rico. Plans for Prisma include a 60,000 square-foot children's and science museum with core exhibitions on arts and culture, science and technology, and biodiversity. Other planned features include an early childhood center, multimedia library, butterfly conservatory, and IMAX theater. *Exploration Park* is under development, and is slated for completion in 2002.

Ten criteria, listed below, guided design development for the Puerto Rico project. (Chermayeff and Berner 1999).

1. Listen to the rhythm.

Each project sets its own goals, each institution has its own dynamic, and each culture defines its own sense of place. Determine the exhibition's focus, key themes, and educational goals. Build upon the institution's existing exhibitions and programs. Consider the users—their ages, interests, backgrounds—and how they will experience the exhibits. Then remember that kids will invent new ways to use the playground that you never imagined.

Prisma targets children 5-12 years old with special areas and programs for toddlers, teenagers, and adults. Early focus groups and front-end evaluation revealed that Puerto Ricans often visit museums in large, extended family groups of up to sixteen people, and that "crowded" is a very positive response. Institutionally, the goal was to develop *Exploration Park* as a sustainable, freestanding installation that heralded the key themes and pedagogical approach of the planned institution.

2. It takes a village.

Bring together multidisciplinary minds. Early in the design process, assemble a group of experts who think about science, play, space, and learning in diverse ways. And, of course, don't forget to listen and talk to the users—kids, parents, teachers, museum staff—throughout the entire process.

The *Exploration Park* team included museum and education specialists in science, early childhood, and youth education. Puerto Rican content advisors included an archaeologist, botanist, and musicians; exhibition developers; play equipment designers; landscape architects; structural engineers; and playground safety experts.

3. Learn from others.

Respond to local needs and interests, while taking advantage of the extensive research and development of other institutions. Visit existing facilities, talk to others in the field, review materials from other institutions, hire an experienced team, read everything you can.

The outdoor exhibitions had to be affordable and require low maintenance by the start-up institution. The project's accelerated schedule and tight budget allowed for little testing, shakedown, or evaluation of new exhibit components. With the understanding and consent of the client, successful, existing exhibit components developed by leading museums and educational institutions were adapted and incorporated into the design whenever appropriate. This approach is also intended to enable the park to successfully operate immediately upon opening, minimize the chance of exhibition failure or breakdown, and provide visitors with a positive initial experience of Prisma. It also allows staff training and pre-opening preparation for interpretation and maintenance to take place at other institutions during construction.

4. Location, location, location.

Use the environment. If the site is located adjacent to wetlands, extend a boardwalk into the cattails or marsh grass; if there is water or other natural features, create access and use these features as a springboard for development of exhibitions and activities. Think about visitor comfort—understand the seasonal path of the sun and its impact on people and activities, provide rain shelters and sunshades to address local conditions.

At Prisma, the challenge was to create an oasis on a site with limited natural features, built on landfill, adjacent to a busy road and small airport, and in the midst of the five-year, ongoing construction of a new convention center. To overcome these limitations and create different play environments, the site is organized around a large central open lawn and man-made pond, surrounded by dense perimeter landscaping that conceals a security fence. The design includes programmatically-driven, content-rich plantings including a wooded edge called the Ice Cream Forest and a sensory garden; a berm with an archeological dig; and a vine-covered music pavilion. A large sculptural tensile structure over the main water feature shelters visitors from intense sun and sudden rain; and the area is further cooled by a system that sprays a fine mist of water.

5. Don't cramp their style.

Children enter outdoor exhibitions running, shouting, jumping, and climbing—activities that are not only tolerated, but welcomed as part of the learning process. Design the playground to encourage children to take time to assimilate a concept, or share it with others. Create opportunities for both active and reflective learning, allowing generous space around all activities to encourage group participation as well as observation. Create "learning geographies" by grouping and juxtaposing activities by theme, educational content, or type of experience. Use organizing features such as paving or pathways, transitional landscaping, and bold structural or graphic statements to provide overall integrity to the site.

Exploration Park is unlike any other educational environment on the island of Puerto Rico. Upon entering the park, visitors are greeted by a large climbing structure capable of absorbing and channeling group energy—especially of class groups pouring off the cramped school busses. Rio Loco, a 150-foot long water installation, contains over thirty kid-powered activity stations that explore physics through water control and manipulation —the more minds and hands that work together, the more rewarding the experience. Optic and energy exhibitions line the Parapet Wall overlooking the expanse of the Great Lawn, an area designed for special programs and casual gatherings. Mist from the nearby Fog Garden creates a mysterious, cooling atmosphere and responds to changing climatic conditions. Ponds and waterways offer more high-energy interactive play with ferry rafts and jump-on fountains. The biodiversity of Puerto Rico is celebrated in a series of planted activity areas - the Scented Garden, Ice Cream Forest, and Nest Building Island. Some activities are open ended, as with the stone xylophones, dance chimes and other unusual instruments found in and around the Music Pavilion; while others, like the The Dig, an archaeological exploration, lend themselves to structured, group programming.

6. Act your age.

Design age-appropriate exhibits. Complex or physically challenging exhibits capture the imagination and attention of older children, while separate early childhood areas serve the younger set with developmentally appropriate activities in safe, controlled settings.

Early in the Prisma planning process, a brainstorming workshop was conducted with children's museum staff and related professionals. One of the unanimous recommendations was to designate early childhood areas interspersed throughout the park. We created a secured early childhood Rio Poco Loco adjacent to the more challenging Rio Loco, an accessible pre-school tree house near the 7.4-meter climbing structure; and a gently rocking land-mounted dinghy away from the intense kid-powered water ferry. At each location shaded seating is provided for adults allowing them to interact with their young children, while monitoring their older children in the adjacent play areas.

7. Wet and messy.

What can you do outside that you cannot do so easily inside? Get wet and messy! Water is a tremendous attraction. Sand and dirt are natural tools for learning. Opportunities for getting wet are almost unlimited; fountains, waterfalls, streams, Archimedes screws, waterwheels, wave machines, ferries, locks, dams, fishing and frog ponds are all fun experiences that lead to scientific inquiry.

Given its location and tropical climate, water is used extensively throughout the park. Rio Loco offers dozens of water generating and manipulating units. Kids cross the pond by a self-powered ferryboat, exploring first-hand, the concepts of floatation, buoyancy, friction, and inertia. The Climbing Zone and early childhood tree house are essentially enormous sand play areas. The Scented Garden and Ice Cream Forest offer tremendous possibilities for many hands in the soil.

8. Safety first.

Ensure that safety standards are met. Before designing the exhibition, review Robin et al (1999) to become familiar with the safety, developmental, and accessibility issues for outdoor play environments. Consult with a safety expert certified by the American Society for Testing Materials <www.astm.org> *throughout design-development, fabrication and installation. Review insurance requirements and considerations.*

During design development, the plans for *Exploration Park* were reviewed by a certified safety inspector. An on-site inspection of the equipment installed by the German manufacturer was undertaken by a representative of the European TÜV standards.<www.de.tuv.com>. A final safety inspection of the entire park will take place prior to opening.

9. I'll huff and I'll puff.

Select appropriate materials for outdoor exhibits. Safety, durability and cost are key considerations. Early in the process, test materials for weathering and durability outdoors under the specific climatic conditions. Use durable materials requiring minimal maintenance such as treated wood, metal and plastic. Be aware of the different qualities and limitations of materials. New and advanced building materials appear on the market daily—ask the project designer for updates. Include the chief of exhibition maintenance in team discussions and develop an annual maintenance budget.

All elements of *Exploration Park* are designed to withstand the extreme tropical conditions: intense sun, frequent downpours, annual hurricanes and high winds, and constant high humidity. The stainless steel water equipment at Prisma was selected for its demonstrated high durability and low maintenance, and a brushed finish used to minimize heat absorption. Plastic lumber was used for decks and bridges because of the termites and rot common in this climate. Walking surfaces were lightly textured for traction, but not so dense as to hold water and become moldy. All painted surfaces were specified to be powder-coated for durability and colorfastness in the intense sun.

10. Try and try again.

Make prototypes of the exhibits, make mistakes, make them better. If possible, test the exhibits in the museum setting or under similar conditions. Even the finest theoreticians and designers cannot predict how an exhibit will perform with the visitors. Build the exhibit, use it—be brave about redesigning it, and remember to account for the inevitable "re-dos" in the original budget.

Several new water-based units were developed for *Exploration Park*. The kid-powered waterwheel began as an idea with a group of San Juan school children. It was drawn by the designer; engineered by Richter Spielgeräte GmbH, the manufacturers; tested on the local village playground in Germany; and installed at Prisma—waiting for young explorers. It may still be fine-tuned after installation, based on summative evaluation.

CONCLUSION: NEXT STEPS

Science playgrounds are tantalizing invitations for children and adults to investigate the physical world. Properly designed and constructed, they allow curators and designers to create large-scale learning environments beyond the confines of museum walls.

In designing science playgrounds remember that play is not just a marketing gimmick, but rather an essential criteria in exhibition development. As we create, augment and modify science playgrounds, we must continue to evaluate and think.

- How can we help visitors make connections between exhibition experiences and daily life?
- How do we support adults—parents and educators—to support their children?

- Can we apply this knowledge by returning it back to community and school playgrounds?

Our challenge is to provide communities with resources that enrich and improve children's lives. By building playgrounds in educational settings such as museums, we teach science and, perhaps even more importantly today, we celebrate play. Play is vital to our children's lives today, and creates the building blocks for their future.

REFERENCES

Bruner, J. 1972. Nature and Uses of Immaturity. *American Psychologist* 27/8. Washington, D.C.: American Psychological Association.

Chermayeff, J. C. 1998. *Notes from Interpretive Strategy Workshops*. Prepared for the New York Hall of Science.

Chermayeff, J.C., and C. B. Berner. 1999. Kids at Work: Looking and Listening at Science Playgrounds. *Hand to Hand*, 13/3:4-7. Washington, DC: Association of Youth Museums.

Diamond, J. 1996. *Playing and Learning*. Washington, D.C.: Association of Science-Technology Centers.

Exploratorium 1999. *Report, Outdoor Exploratorium Design Workshop.* July 23-24*,* 1999. San Francisco, CA: Exploratorium.

Hofferth, S. and J. Sandberg, 1997. Children's Time*. Child Development Supplement - Panel Study of Income Dynamics.* Ann Arbor, MI: Institute for Social Research, University of Michigan.

Hood, M. G. 1993. After 70 Years of Audience Research. What Have We Learned? Who Comes to Museums, Who Does Not, and Why? *Visitor Studies: Theory, Research, and Practice* 5: 23.

Moore, R., S. M. Goltsman, and D. S. Iacofano, 1987. *Play for All Guidelines: Planning, Designs and Management of Outdoor Play Settings for All Children*. Berkeley, CA: MIG Communications.

National Academy of Sciences 1995. *National Science Education Standards*. Washington, D.C.: National Academy Press.

Neulinger, J. 1974. *The Psychology of Leisure: Research Approaches to the Study of Leisure*. Springfield, IL: Charles C. Thomas.

New York Hall of Science. 1998. *Welcome to the Science Playground*. Flushing Meadows-Corona Park, NY: New York Hall of Science.

Van Hoorn, J., P. Nourot, B. Scales, K. Alward. 1999. *Play at the Center of the Curriculum*. Upper Saddle River, NJ: Prentice Hall.

Wasserman, S. 2000. *Serious Players in the Primary Classroom: Empowering Children through Active Learning Experiences*. New York, NY: Teachers College Press.

NOTE

1. The ten criteria for design development of outdoor exhibitions that were applied in the development of *Exploration Park* were first published in Chermayeff and Berner (1999).

Captions:

1. *Science Playground,* New York Hall of Science, Flushing Meadows-Corona Park, New York.
2. *Science Playground* Energy Wave: “It’s like an echo.”
3. *Science Playground* Spider Web: “Vibration is like a message.”
4. Model of *Exploration Park*, Prisma, Zona Exploratoria de Puerto Rico, San Juan, Puerto Rico. © Chermayeff & Geismar, Inc.
5. Site map of *Exploration Park*, Prisma, Zona Exploratoria de Puerto Rico, San Juan, Puerto Rico. © Chermayeff & Geismar, Inc.
6. Concept drawing for kid-powered waterwheel. © Günter Beltzig Playdesign, Germany.
7. Testing of prototype waterwheel at manufacturer’s workshop. © Richter Spielgeräte GmbH.
8. Installation at *Exploration Park*, Prisma, Zona Exploratoria de Puerto Rico, San Juan, Puerto Rico.

Photography credits:

1. Jane Clark Chermayeff
2. Jonathan Levine, Jane Clark Chermayeff Associates LLC
3. Jonathan Levine, Jane Clark Chermayeff Associates LLC
4. Chermayeff & Geismar, Inc.
5. Chermayeff & Geismar, Inc.
6. Richter Spielgeräte GmbH
7. Peter Heuken
8. Peter Heuken