

Spark!Lab Interview and Observation Study



Smithsonian Institution

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Table of Contents

Preface	3
Introduction to Spark!Lab	4
A Brief Overview of Spark!Lab	4
The Mission of the Lemelson Center	4
Activities Descriptions	5
Purpose of this Study	6
Methodology	6
Visitors.....	8
Reasons Why Visitors Come to Spark!Lab	8
What Visitors Do at Spark!Lab	10
Spark!Lab Visitors' Interests in Science.....	11
Children's Intent to Finish	12
Visitors Connecting with the Spirit of Invention	12
Repeat Visitors and Long Stays in Spark!Lab	12
What Visitors Take Away from Spark!Lab	13
Other Science Centers.....	16
Improvements.....	17
Space	17
Acknowledge Achievement	17
More Levels of Difficulty to Challenge Visitors.....	17
Activities	18
Redesign.....	19
Communication	20

Preface

In the summer 2010, the Office of Policy and Analysis (OP&A) conducted a study of Spark!Lab at the request of the Lemelson Center for the Study of Invention and Innovation at the National Museum of American History.

The Spark!Lab observation and interview study focused on the experiences of children and their families and it is hoped that this report sheds light on how visitors responded to different elements in Spark!Lab, as well as how to best improve the space to meet both the goals of the Lemelson Center and the needs of visitors. The study proved to be both a challenging and enjoyable experience for the OP&A study team, which was led by OP&A's Andrew Pekarik, along with Zahava Doering and Ikuko Uetani. Rachel Haswell and Lindsay Kelly, OP&A's summer interns, were integral to the project; they conducted qualitative interviews, observations and analysis, and co-authored this report, which was edited by Claire Eckert. I thank them for their hard work, enthusiasm and talent for making astute observations.

I thank the staff at the Lemelson Center, Tricia Edwards, Tanya Garner, Steven Madewell, Aaron Alcorn, Catherine Kruchten and Christopher White for their efforts in facilitating this study and contributing their time, expertise and valuable observations. Their support was vital to this project.

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Introduction

A Brief Overview of Spark!Lab

Spark!Lab is located in the National Museum of American History (NMAH) and is part of the Museum's Lemelson Center for the Study of Invention and Innovation (Lemelson Center). It is a place with hands-on science and invention related activities geared towards families with children age 12 and under. Spark!Lab is different from most museum spaces because it is interactive and designated especially for children. Spark!Lab's purpose is to "use fun activities to help kids and families learn about the history and processes of invention."¹ The space houses a lab bench (stretching from one end of the room almost to the other in a curved shape) where experiments are carried out by Spark!Lab staff who are often dressed in white lab coats. Here visitors can look on and sometimes participate in several different experiments which occur every hour. Adjacent to the large lab bench are various tables with self-guided activities. Visitors are free to touch and interact with the materials and contraptions at each activity table. Close to the entrance, there is a separate "Under-5 Area" with activities that are appropriate for younger Spark!Lab visitors. Spark!Lab is a dynamic and social space with staff, parents and children interacting, exploring, experimenting and learning.

The Mission of the Lemelson Center

The Lemelson Center's mission is:

To document, interpret, and disseminate information about invention and innovation...to encourage inventive creativity in young people...[and] to foster an appreciation for the central role of invention and innovation in the history of the United States.

To accomplish this mission, the Lemelson Center:

Records the past, by preserving and increasing access to records and artifacts. [It] broadens our understanding of history, through research, discussion, and dissemination of ideas. [Finally, it] looks toward the future, by engaging young people in the study and exploration of invention and innovation.

Spark!Lab, which complements the Lemelson Center's exhibition *Invention at Play*, inspires visitors to explore invention processes and to "identify a problem or need, conduct research, make sketches, build prototypes, test the invention, refine it, and market the invention."²

¹ Spark!Lab website (sparklab.si.edu)

² Spark!Lab website (sparklab.si.edu)

Activities Descriptions

Spark!Lab offers a variety of activities that illustrate and allow visitors to participate in the invention process. Activities are designed to appeal to different learning styles, ages and levels of ability, and incorporate a variety of disciplines including history, science, engineering and art. Spark!Lab provides children with an Inventor's Notebook when they enter. The worksheets inside are designed to encourage children to reflect on the processes that they—and real inventors—use in their work.

Spark!Lab activity stations include:

Invention Corner – Here, visitors are given a challenge or problem to solve and simple materials with which to solve it. Both the materials and the problems/challenges change on a periodic basis. The *Build-a-Vehicle Challenge* currently occupies this station.

Invention at Play Kits – Leveraging the content of its popular *Invention at Play* exhibition, the Spark!Lab staff created five bilingual education kits. Each kit includes an example of a real life invention, in addition to an activity relating to that theme. The themes include: *It's a Material World* (innovative materials), *Naturally Inspired* (inventions inspired by nature), *Shaping Space* (building creative structures), *Soundscapes* (making sound and music 'pathways'), and *Now What?* (solving problems with simple materials).³

Inventor's Files – The Spark!Lab staff worked with the Museum's Archives Center to select invention-related collections for the Inventor's Files activities. Each box includes reproductions of archival materials such as photos, inventors' sketches, patent drawings and marketing materials, and tells the story of a particular inventor and his or her process of invention. Each box also includes a hands-on activity related to the invention.⁴

What Can You Build? – Visitors can use a variety of building toys, such as LEGO bricks, Lincoln Logs and ZOOB, to build structures, machines or inventions of their own designs. Children are encouraged to sketch their designs first and then collaborate with others.

How Does It Work? – Visitors can explore a variety of science concepts through hands-on activities to learn about how things work. Activities include *Snap Circuits*, which help kids learn about electricity and electric circuits, and *Gyroscopes!*, which illustrate gyroscopic principles.

Experimentation Station – Spark!Lab offers staff-assisted activities involving real chemicals and scientific equipment at its built-in lab bench, these include *Conserving the Star-Spangled Banner*, *It's a Gas (Properties of CO₂)*, *Food Additives*, *Germs!*, *DNA extraction*, and *Benjamin Franklin's Electrical Experiments*.⁵

Under-5 Area – To accommodate young visitors, Spark!Lab has a small area with activities appropriate for children under the age of five that foster creativity and problem-solving skills.⁶

³ *Soundscapes*, *Now What?* and *Naturally Inspired* are year-round, while the other two rotate.

⁴ Currently, the Charlotte Cramer Sachs (cake mix) and Orla Watson (shopping cart) boxes are out.

⁵ Experiment topics vary by day and are typically offered every hour on the hour between 11 am and 3 pm.

⁶ Lemelson Center's Spark!Lab Overview 2010

Purpose of this Study

Spark!Lab's predecessor, the Hands On Science Center, presented experiments and activities in connection with an adjacent exhibition *Science and American Life* and in spring of 2006, the Science Center's Director, Matthew White, asked OP&A to assess the Science Center's performance in a visitor study, with the intention of redesigning the space. The OP&A utilized qualitative research methods including interviews and observations of visitors, an exit survey, and a group interview conducted with docents and other Hands On Science Center staff. The study team concluded that the public highly supported the idea of a hands-on activity lab that portrayed science as special and fun; however, there was clear room for improvement in the areas of display, maintenance, and visibility. The Lemelson Center took over this space, rebranded it as Spark!Lab and incorporated many of the lessons from the OP&A's Hands On Science Center study. This report represents a new phase of analysis that is aimed at understanding Spark!Lab's impact on visitors and improving visitors' satisfaction.

The Lemelson Center is planning a major renovation, including a complete redesign of its Spark!Lab. This interview and observation study is one of three major projects to aid in this redesign. The other studies include a) a visitor survey, and b) a design/research study to better understand Spark!Lab visitors and the implications of specific changes. The Museum is focused on learning how visitors respond to different elements in Spark!Lab and how to best improve and change the space to meet goals of the Lemelson Center and the needs of visitors.

Methodology

This is a qualitative observation and interview study. Avoiding any pre-formulated conceptions about the public's desires, it seeks to understand what is happening in the space by observing and talking with visitors, who often provide unique insights when allowed to speak freely. Through in-depth interviews, visitors were able to candidly share their thoughts and impressions of Spark!Lab. This study is based on 19 interviews with 38 visitors (21 adults and 17 children) and approximately 10 hours of observation.

- Three times as many women as men were interviewed.
- About half of the interviewees were local.
- Ages of adult interviewees ranged from early twenties to late sixties.
- Parents, grandparents, aunts, and teachers made up the adults that were interviewed.
- At least four parents interviewed worked in the science or history professions.
- 11 girls and 6 boys were interviewed along with the adult that accompanied them.
- The ages of children interviewed ranged from 3 to 12.
- Most of the interviewees participated in table activities.

These interviews do not provide quantifiable insights into visitor trends. Therefore, a visitor survey accompanied this qualitative study. The OP&A study team worked alongside the Spark!Lab staff to administer a short survey and has been sharing its research findings incrementally, throughout the duration of the study. It is OP&A's hope that the initial qualitative responses will pave the way for new ideas. Indeed, the Spark!Lab staff has already taken steps to improve the layout of aspects of the space in response to early findings; for example, they moved the archway of the Under-5 area further from the exit to deter young children from running out directly into the rest of the space; additionally, they transferred the popular *Soundscape*s activity from its original place on the lab bench to the center of the floor, where more children can comfortably participate.

Visitors



Photo by Rachel Haswell

Reasons Visitors Come to Spark!Lab

To Touch and Interact. Spark!Lab is a space where children can touch and interact with a variety of materials. Children are very interested in hands-on activities and it has been observed time and time again by OP&A study teams how enthusiastic children are about touching things in museums. The parents who were observed were also aware of how captivated their children were by touch, and they praised Spark!Lab for offering a unique platform for such hands-on interactions.

Parent: The hands-on aspect of it really is huge for them because normally they're told, "Don't touch this. Don't touch that." So this space is more up their alley.

The ability to touch drew many visitors into the Spark!Lab and the satisfaction they derived from it often kept them in the space for extended periods.

Parent: [We didn't come here today specifically for Spark!Lab], But once we got here we said we might as well have a look around and when we saw that the children could interact, we stayed. If there had been no interaction for the children we would have left right away.

For those who visited Spark!Lab, or museums in general, for an educational experience, the ability to learn-through-doing enhanced their overall experiences. Children in Spark!Lab really engaged with what they touched, which is important as a way to understand concepts, processes and the history related to invention and scientific discovery.

Parent: Science is definitely more memorable when they touch it.

To Experience a Children-Focused Space inside of the Museum. Spark!Lab is designed specifically for children and their families, which sets Spark!Lab apart from most other spaces in

NMAH, which cater to all ages. Parents and children appreciated having a special space devoted to them.

Parent: *It's fun and it's nice to have a place like this at a museum for kids this young - something for them to do.*

To Have Freedom and Self-Guided Activities. Parents spoke about a sense of freedom that Spark!Lab engendered in their children. The discovery, invention and experimentation processes that go on in Spark!Lab are largely initiated and carried out by children. Although parents and staff sometimes provided guidance, Spark!Lab empowered children to do things on their own. This is a unique experience that Spark!Lab offered to children who may not have that same freedom in other parts of the museum or in other parts of their lives.

Parent: *They loved the idea that they could do something that they never thought they could do. The knowledge that they were capable of gaining was huge for them. Especially kids nowadays are not used to just going out on their own and playing and discovering stuff on their own or just building a fort in the back yard.*

* * *

Parent: *I think this is a great space for them to feel free to just do anything wacky or crazy and see if it works.*

Children, like their parents, recognized that Spark!Lab was a unique place for them to experiment on their own, and they really enjoyed being their own guides. The freedom, as a seven year old girl mentioned when asked what she liked about Spark!Lab, to “do whatever [they] want” appealed to children.

To be Creative. Children were encouraged to find their own paths, create their own projects and to be spontaneous and imaginative.

Interviewer: *It sounds like creativity is really what you value in a space like this.*

Parent: *Yes. We let the kids be creative. [Spark!Lab] gives them enough of a structure to give them a bit of a roadmap but it doesn't exactly tell them what to do.*

Creative freedom is a hallmark of invention which pulses throughout Spark!Lab, so it is no wonder that Spark!Lab empowers children to think creatively. Visitors appreciated the way that Spark!Lab's staff, activities, and atmosphere facilitated the creative process.

To Learn. Spark!Lab offers an innovative, fun, hands-on and exciting way for children to learn about history, inventors and inventions, mechanics, engineering, science and art. Children and parents alike, appreciated that Spark!Lab goes beyond a play space to be an area where children can learn. Spark!Lab facilitates different types of learning. In this environment, children develop scientific, creative and practical skills. The activities and experiments allow children to learn in a unique, self-propelled way.

Parent: *I think learning is the key because if you just want the children to be occupied, then don't take them to the museum. They can just go to daycare. The idea for us,*

personally, we want them to learn something. It's not about entertaining them, it's about educating them in a fun way—teaching them science in a fun way, teaching them music and sounds in a fun way, teaching them how to build something in a fun way. I think it should be fun.

Parent: I think [Spark!Lab] goes beyond the average school district. We have a wonderful school system, but this is more hands-on and practical experience. We all talk about “book smart.” I think this allows them to be a little bit creative, and it also allows them to say A plus B equals C but what's beyond that. This is great.

What Visitors Do at Spark!Lab



Photo by Rachel Haswell

OP&A observed that some visitors moved between lab bench and table activities, while others concentrated on one activity during the entire time of their visits. At the bench experiments, visitors followed a Spark!Lab staff member or volunteer. Table activities were facilitated, self-guided or had written instructions.

Below are some examples of things that children were up to at Spark!Lab.

Children who work on the *Snap Circuits* were excited about making the propellers “fly.”

Parent: There was this thing where you build a circuit. You can put the propellers on that, and then you realize that doing this will make it spin. One of the scientists came over and showed [my son] that the motor turned this way, so for the propeller to spin you turn the motor around and when he tried again he said ‘It flies! It flies!’

Children who worked on the *Build-a-Vehicle Challenge* sometimes completed the challenge of

building a vehicle to transport goods. Other times children worked to create their own wheeled objects which did not fit the challenge criteria but which the children were diligent about creating.

Parent: *What are [your cousins] building?*

Seven Year Old Girl: *A car.*

Parent: *Are you trying to build a steering wheel for the car?*

Girl: *Yes, for that car.*

Parent: *Are they building two cars? I guess that's the fun part about it.*

Parent: *You're trying to make a double-decker, aren't you?*

Girl: *[My cousins] were.*

Children created very unique structures with many possibilities in the LEGO activity.

Interviewer: *Tell me what you've done in Spark!Lab today?*

Nine Year Old Boy: *Right now I'm making a boat that can transport trees. I made it open so that trees can get rain and sunlight. Right now I'm making that.*

Interviewer: *What made you decide to make this?*

Boy: *I thought that if this design was created it might actually someday be invented.*

Interviewer: *What do you think it would be used for?*

Boy: *Probably the transport trees and other goods*

The *Soundscape*s activity allowed children to build off of previous constructions. Often times, children repeatedly tested their designs to achieve a certain effect with the marbles.

Nine Year Old Boy: *I was making a music maker out of the blocks. I dropped the marble. It rolled down, hit the five music notes, and then landed inside. When I went over there, I saw some other designs.*

Parent: *You kind of modified other designs.*

Boy: *Yeah, modified. I worked with some of what was already built.*

Parent: *The musical steps were already built. Then you made a bunch of different ramps and built locks up so that it would be longer. You were testing it.*

Boy: *You have to test it three times.*

Spark!Lab Visitors' Interest in Science

Many of the visitors had a pre-existing interest in science. Some parents were science professionals, which may explain why some of the children had an appreciation for science. Other children had developed their interest in science on their own. Spark!Lab propelled that scientific interest and gave it an outlet.

Parent: *I think [my son is] getting interested in science. He just had me check a video out of the library that had to do with science, so I know he's interested but I don't think he's done that much with it.*

Children's Intent to Finish

Spark!Lab activities compelled some children to have goals that they aimed to reach in order to complete their projects. Some goals were very clear to the children from the outset, either through written directions or suggestions from Spark!Lab staff and volunteers. For example, to complete the *Snap Circuits* activity, visitors had to connect different components to make a propeller spin, a goal that was stated in the directions. Other times, goals were created by the children and may or may not have been known to them at the start of the project. Even if there was no pre-determined outcome, in many cases it seemed that the child had an outcome in mind that he or she was striving toward. In other words, most children were not indiscriminately playing, but rather envisioning and producing end products.

In some situations, children did not have the adequate building blocks or skills to accomplish exactly what they had envisioned; however, that did not appear to take away from children's experiences. They freely changed tactics or moved on to new activities when the end goal was not being realized.

Visitors Connecting with the Spirit of Invention

Interestingly, children frequently chose to abandon the instruction sheets at the various activity stations. Adopting a spirit of invention, they applied creativity and persistence in setting their own goals. Often the children who designed their own activities seemed to be equally, if not more, excited by their successes as those who had followed instructions.

Repeat Visitors and Long Stays at Spark!Lab

Many of the adult interviewees had been to Spark!Lab before or had returned at their children's requests. One mother of three noted that on her family's first trip to NMAH, they passed Spark!Lab but did not have time to go inside. Since that time, her daughter had asked for several days to come back to Spark!Lab and on their return they spent over an hour in the lab.

Other visitors, whether it was their first or fifth trip to Spark!Lab spent more time in this space than any other space in the Museum. Through observations and discussions it was apparent that families would spend as much time as necessary to satisfy their interests in the space.

Parent: I think the children needed this here to interact with things. The kids could easily be entertained for hours just in here.

What Visitors Take Away from Spark!Lab



Photo by Rachel Haswell

Children Have Experiences that Go Beyond Play. Parents and teachers commented that Spark!Lab facilitated children’s development. The structure of the activities and the way that children carry them out went beyond superficial interactions. Adults believed that their children would take away building blocks for future endeavors.

Teacher: It could be as simple as doing a little science experiment here and build up on that idea to make something.

It was assumed that children would share their experiences and the lessons they learned with others, such as classmates, parents and siblings.

Teacher: They’re doing more hands-on applications with the stuff that they can hopefully bring back and share with the other kids.

Spark!Lab encouraged children to generate new ideas. Children mentioned that this space helped develop and guide their interests. Children were able to look beyond the activity that they were working on and comment on other original associations and ideas that the activities sparked.

Interviewer: You wanted to build something that would be helpful?

Nine Year Old Boy (On his LEGO boat): This would be helpful to bring different cultures to different countries. There could be plants in Asia that we barely even know about. We have to send lots of scholars on boats so we get to these plants. Why can't we just bring the trees here?

Parent: We went to the botanical garden and we looked at the plants from all over the world

Boy: *This way we could see them up close, and all of the American scholars could look at them here instead of just driving boats to other countries*

Children Met Goals and Challenges. During the activities, challenges would arise that children had to work to overcome in order to meet their goals. The importance of overcoming obstacles is a valuable lesson that is taught at Spark!Lab. Parents recognized the value of overcoming challenges and the joy that comes from achieving success.

Parent: *I just think children like to think of things, build things, invent things and then to see it work. You know that's just a big deal.*

Parent: *They keep trying something and keep trying something and then it works and their faces light up.*

Parent: *It's good for kids to do things that are project based because they know there's an answer that they must get to.*

Parents Learn New Things About Their Children. The Spark!Lab environment gave some parents new perspectives on their children. Sometimes, parents discovered completely new personality traits and interests of their children. For example, one father saw his daughter's fascination with the motion of the marbles in *Soundscapes* and concluded that his daughter's background in sports created this interest in motion. This father noticed that his daughter was motivated to seek out more opportunities to develop that interest.

Children Participating in Social Learning. The activities allowed children to learn through modeling and collaboration. By working with other children and the Spark!Lab staff, many children participated in a social process by which they drew from other children's experiences and trials. This was particularly common with activities such as *Soundscapes*, *LEGOs*, *Snap Circuits*, and the *Build-a-Vehicle Challenge*. The vehicle activity encouraged children to pick up projects where others had left off and to model their projects after projects that they had seen others build.

Collaboration is another way social learning is cultivated. Older children taught younger children how to perform certain tasks. For example, in the Under 5 Area an older sibling taught a younger sibling how to write the alphabet on a chalk board. Groups organically formed to work toward the same goal and ideas were shared among children. In *Soundscapes*, a group of children built marble runs and the youngest girl in the group facilitated their actions by anticipating the pieces that they would need. Spark!Lab promotes teambuilding and nurtures an environment where sharing is easy, natural and appropriate.

Parent: *Well teambuilding is going on. I don't really think they have this kind of stuff at school. You never know [what could happen when] different people are taking turns in a group. They are sharing ideas and experimenting.*

Beyond the Activities. Despite the emphasis on the hands-on activities, Spark!Lab's appeal reached beyond the purely physical. In fact, one of its greatest accomplishments appeared to be the extension of learning beyond the activities themselves to forms of social discovery. Visitors

seemed to leave with a better understanding of team building and collaboration. Activity clusters motivate young visitors to observe others and learn from each other, often creating a very dynamic setting. Some comments and responses by visitors showed that they have a clear understanding of America's connection to invention, and more specifically of Spark!Lab's connection to American invention. A 30 year-old teacher and chaperone of an inner-city, government-funded camp provided the study team with one of the most insightful responses:

I definitely think they'll take away something from this...you know, the idea that in America you can do anything and realize your dreams.

Children Work in the Spark!Lab Book. The Spark!Lab's Inventor's Notebook is a take-away souvenir that is given to children when they enter and is worked on alongside their projects. This not only preserves the memory of Spark!Lab but allows them to share their experiences with others after they leave.

Parent: *They'll have The Spark!Lab book when they go home to spark the memories of stuff.*

Six Year Old Boy: *I like the LEGOs.*

Parent: *You like the LEGOs. You're making a drawing of it.*

Parent: *At every station he's done and observation of what he's worked on.*

Boy: *I'm trying to remember [what I did].*

Parent: *So are you going to write that down?*

Interviewer: *Will you look at this later?*

Boy: *Yes.*

Parents Feel that this is a Special Opportunity. In a society in which children increasingly interact with the virtual instead of the tangible, access to educational and fun hands-on activities is appreciated by adults and children alike. One visitor put the dilemma of the technological age quite bluntly:

[These days] everything is Wii or Playstation, which are creative but certainly...they don't get as much hands-on experience in the real world.

The study team listened to visitors praise the hands-on activities for a variety of reasons, they allow children the freedom to touch and manipulate objects, which is rare in a history museum; use materials, processes and learning styles that resonate with children; teach the payoff of persistence and never giving up; and provide children with an enhanced sense of accomplishment.

Other Science Centers

Some of the Spark!Lab visitors the OP&A team spoke to had been to other science centers and had really enjoyed these spaces. For these visitors, Spark!Lab compared favorably to other centers. Spark!Lab also has elements that are unlike other science centers, especially the ability to touch and do hands-on activities.

Parent: We have a science center in West Palm Beach. [My son] went on a field trip there last year, but they didn't really have an interactive room like this. He's really enjoying it as you can see. He's totally into it.

One interviewee commented that some science centers have large scale activities that resemble rides, such as the Center of Science and Industry (COSI) in Columbus, Ohio:

Parent: We've gone to COSI in Columbus.

Seven Year Old Girl: It's a museum that has a ride where you stand against the wall and it goes around in circles.

Parent: And what happens?

Girl: You stick to the sides.

Parent: What happened to the floor? The floor fell out.

Parent: [Spark!Lab] is pretty good [in comparison]. It's very hands-on. There are some other science centers that are hands-on. There was one where we saw they did a science experiment where they showed you how the clouds were made. That was actually at COSI too. They had fireworks. They created pseudo- fireworks inside of the lab, but that was where the instructors were upfront. That was pretty neat.

The overall size of other science centers also differs from Spark!Lab. For instance, one visitor mentioned that Technorama in Europe takes up three floors. Other science centers mentioned were Please Touch in Philadelphia, the New York Hall of Science, the South Florida Science Museum, Center of Science and Industry and the San Francisco Science Center.

Improvements

Space

During high-volume periods, it almost instantly became difficult to hear and move. One eight year old girl commented:

I don't really like noise when I'm trying to work. It distracts me.

Indeed, the lack of space created a pressure-filled atmosphere that, based on OP&A's observations, was enough to deter some potential visitors from entering. The most common visitor suggestion was to increase the available space, as reflected in the following comment:

Parent: I think they could probably expand the space. I think it would be more interesting and they could get more hands-on experiments going. So if [more] kids could use this I think that would be better.

Aside from expanding the space, other measures could be taken to make better use of the available space. An easy method for minimizing congestion is to time experiments for every fifteen minutes during busy periods, so as to divide more children among the bench areas. Additionally, signs or maps with the locations of various activities should be placed at the entrance and/or inside the space, which may help alleviate some confusion and wandering.

Acknowledge Achievement

OP&A witnessed the thrill of a child's moment of success. Through the study team's glimpses at the excitement that invention and science offer children, the team realized the great potential for expanding this excitement. Having Spark!Lab docents more readily distribute pins, certificates of achievement and various other prizes for children's inventions are great ways to capture a child's triumphant moment. Staff could even post pictures of particularly extraordinary inventions on a Spark!Lab Wall of Fame.

More Levels of Difficulty to Challenge Visitors

Increasing the number of experiment levels would promote continued discovery for those children who do not feel challenged by what is currently offered. This idea has particular importance because there is a wide educational gap within the audience. One parent's perception of the experiments as too basic is captured in the following response:

Parent: [they are] quite basic experiments...this is what they're doing over there. There's the pH scale over there. There is the basic stuff that they pretty much do in kindergarten...Or we can get [that information] in books. It's very basic.

Spark!Lab should introduce multiple levels so parents and children could tailor their experiments to meet their learning needs. One visiting teacher had a suggestion for a new experiment. She recommended conducting "electricity with apples. [She said] it would be fun to see more [non-traditional invention processes]."

Activities in Realms of:

Fine motor skills. Some visitors remarked that there was a lack of activities that utilize children's fine motor skills. While Lemelson Center staff noted the difficulty of keeping track of and maintaining small pieces, the team recognized the possibility of using large equipment with small connected pieces. If added to the Spark!Lab, this would undoubtedly add a new dimension to the developmental activities already taking place.

More parts. Many of the children working in the Invention Corner wanted the vehicles they created to operate in a way they imagined real cars to operate. The most complaints the study team received regarding too few supplies came from visitors participating in this, and other, activities.⁷ Oftentimes children would run out of connecting pieces, resulting in disappointment over not being able to complete a vehicle or structure the "way it's supposed to be." Other suggestions were for new and improved auto parts. Some possibilities would be to add small, attachable motors to the supply of parts or to have an area with racing tracks off to the side. However it is done, there is a need at this station to provide a better sense of completion.

Parent: I think the magnet table is wonderful. If there were a couple more things you could use the magnets with. If you could find one that the magnet is attracted to and what it's not. I think if they had a couple more things—another experiment with the magnets. Maybe a couple more puzzles. A lot of the puzzle pieces were missing.

Interviewer: Are you trying to win the invention challenge?

Parent: I think that's what they started but I think they need more parts.

Eight Year Old Boy: we're running out of parts.

Seven Year Old Girl: Putting the wheels on I couldn't find the part to put it on.

Other children, such as a boy who was working on the *Build-a-Vehicle Challenge*, stood up and left after key parts, such as a steering wheel, were snatched up by other children.

Incorporate more of the senses. The more ways in which visitors can interact with the activities and experiments in Spark!Lab, the happier and more fulfilled they seemed to be. The sense of touch is well established through the many hands-on activities, and sound is incorporated in the *Soundscape*s station. The study team recommends more tactile, sensory, and textured items. Experiments and activities that engage all five senses would enhance the experience that children have in Spark!Lab by reaching a wider audience, since different children have different sensory preferences.

Parent: I don't know if this would be too messy for this area but a sensory table where they could experiment with a jar full of light beans or something where they could experiment with funnels. That's pretty good for her age.

The use of sight is apparent in the popularity of the shiny, golden wheels, patterned pieces, opportunities to use the lab's microscope and the attractiveness of sparking and foggy

⁷ LEGOS were another activity that needed to have more parts added to it.

substances. Nevertheless there is still room for improvement in the creation of interesting surfaces and images. Speaking to parents about what their children were most excited about, there was a large number of responses related to the sense of sight.

Parent: The other day when he got to the carbon dioxide [experiment] and [my son] got to blow out a candle and then he blew bubbles and they changed colors—that was a lot of fun. Then he took that information and shared it with his daddy.

The two overlooked senses are taste and smell. One young girl expressed her desire to combine her interest in food with her love of science. She was disappointed that the lab did not have taste experiments. The opportunity to taste could be included in take-home activities, as it is not possible to provide food to visitors in Spark!Lab. The sense of smell would most effectively be introduced by means of a new experiment.

More activities in the Under-5 Area. The activities in this area seemed to appeal to children well under the age of five. During one observation there was an 18 month old girl playing with almost every activity in the Under-5 Area. Oftentimes the study team observed a two or three year old child accompanied by an older sibling around age five, who did not seem to be challenged by the activities. We recommend offering more to do for a larger variety of age groups in the Under-5 Area. A young mother with three daughters had difficulties keeping her oldest child (still under five) occupied in the Under-5 Area, even though her younger two were perfectly content. A broader range of age-appropriate activities would allow young families to stick together, while at the same time challenge more precocious toddlers.

Redesign

Pathways. Due to the limited space, adhesive pathways on the floor to guide visitors might be helpful.

Posters. The images and posters with text would be more powerful if lowered to the eyelevel of the average child. This consideration is particularly important in the Under-5 Area, where children can barely reach the signs. The text should be enlarged and made more comprehensible for young children. When large or unfamiliar words are necessary to explain the project or historical facts, the study team recommends that headphones accompanied by audio-readers be provided so that young visitors can listen to the explanations.

Lighting. The quiet area received relatively little use, particularly the books, which are located in a dim-lit area where it was difficult to read the titles without straining the eyes.

Seating. When experiments attracted high numbers of visitors, it was very hard for some children to see what was happening. It would help to have children sit on elevated stools or steps at different levels, so that those in the back can participate.

Communication

Create a sharing database with other science centers in the United States. Many interviewees discussed other science museums and centers they had visited across the United States. There were remarkable comparisons, as well as distinctions, among the institutions. Although standardization of activities and experiments is not desirable, discussion among the different centers about teaching strategies and child development could prove quite useful. One possible way to achieve this in a time effective manner would be to create an information sharing database. Sharing research and strategizing on how to best instill a love of learning at a young age is vital to upholding the goals of Spark!Lab.

Some of the specific centers of scientific invention mentioned in the interviews include: the New York Hall of Science (<http://www.nysci.org>); the South Florida Science Museum (<http://www.sfsm.org>); the Center of Science and Industry (<http://www.cosi.org>); and the San Francisco Science Center (<http://www.californiasciencecenter.org>).

Marketing. The majority of Spark!Lab visitors first discovered the space by stumbling upon it during their visits to NMAH. It was clear that once local parents discovered how educational and fun Spark!Lab is for their children, they planned return visits.

Parent 1: *We've been back here five times. The kids keep asking.*

Parent 2 (in response to parent 1): *A lot of people who I talk to don't even know that this is in the Museum. They go to the National Museum of Natural History.*

Parent 1: *I like it that way because it actually limits the number of people here. If all the people from natural history came here it would be so crowded. It's more crowded today than I've ever seen.*

Spark!Lab offers very different amenities than the rest of the Museum. With better marketing, more local families might come to NMAH purely for a Spark!Lab visit.

Parent: *I just had some friends in town and my friends were asking where there was a museum for kids and someone went on Google and found this great website and this one wasn't listed. Just in terms of marketing you might want to look at that. There's a bunch of things to do with kids in DC and this wasn't popping up. That might be something you might want to look into. I've lived in Washington my whole life and I've never been to this Museum but I didn't realize this was great for kids.*

Indeed, Spark!Lab does not appear on websites and other information sources that list places to bring children in Washington, DC. Several news outlets publish lists for this purpose that Spark!Lab should be mentioned on. Another method of marketing is the use of flyers specifically for Spark!Lab. Such flyers could be posted at Smithsonian information centers in other areas marketed toward children, such as at the National Zoo. Marketing to the general public would encourage more families to bring their children to Spark!Lab.

Take away kits. Another marketing suggestion is to provide experiment and activity kits that could be taken home. This would spread knowledge of the space outside the museum

community. One of Spark!Lab's greatest powers is its ability to foster new ideas about invention and science in the minds of children. The best way to encourage continued growth in these areas is to preserve these initial impressions and memories in a physical form. A cost effective version of the idea of take-away kits was raised by a grandmother who said that her family used memory books, in which children were asked to write down three things they learned or discovered and put this list next to either a hand-drawn picture or a photograph from the space. She felt that the children would enjoy looking through these books and they often inspired them to revisit previous sites. A 35 year old teacher reflected a similar recognition of the importance of memory, saying,

They love the books that we got today. They might not even fill that all out but they'll have that when they go home to spark the memory.

The study team overheard families inquire about purchasing items, primarily *Snap Circuits* and parts from the Invention Corner challenge, and saw teachers and group guides jot down instructions and materials for the experiments performed at the bench, perhaps with the intent of restaging the activities at home or in the classroom. A ten year old girl remarked:

I know we can take pictures of them, but we can't have them. I wish at least my mom would buy me the tools for the experiments.

There is sufficient reason to believe that experiment and activity kits, if available to the public, would be in high demand.



Photo by Rachel Haswell