

**TEAMS III
SUMMATIVE EVALUATION REPORT**

December 2008

INVERNESS RESEARCH

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INTRODUCTION

Over the course of three rounds of consecutive funding, the National Science Foundation (NSF) invested in the Traveling Exhibits at Museums of Science (TEAMS) collaborative. Since 1996, the TEAMS collaborative museums have developed traveling exhibitions and related education materials to circulate through each other's museums, and then more broadly to the larger field of science museums. Museums participating in the TEAMS collaborative include:

- Catawba Science Center in Hickory, North Carolina
- Discovery Center Museum in Rockford, Illinois
- The Family Museum of Arts and Science in Bettendorf, Iowa
- The Health Adventure in Asheville, North Carolina
- Montshire Museum of Science in Norwich, Vermont
- Rochester Museum and Science Center in Rochester, New York
- Sciencenter in Ithaca, New York

The third round of funding began in 2004. In addition to developing two copies of four separate traveling exhibitions and related education programs, the TEAMS museums engaged in a shared research effort. Specifically, the collaborative-wide research project focused on applying a socio-cultural learning lens to conversations at exhibits, and how to design exhibits such that the conversations that took place would promote learning. Thus, the third round of funding was intended to produce both a set of traveling exhibitions as well as knowledge for the field about engaging in research into conversations and designing exhibits that promote conversation.

Within the group of seven collaborative museums, three pairs of museums in close geographic proximity to one another worked together to create three of the exhibitions. Four exhibitions were created in this round of funding, including:

- *From Here to There* (Sciencenter and Rochester Museum)
- *Spin* (Catawba and Health Adventure)
- *Get the Message* (Discovery Museum and Family Museum)
- *Toys: The Inside Story* (Montshire Museum)

The Evaluation

Inverness Research¹ has served as the external evaluator on the TEAMS project for all three rounds of NSF funding. As in the first two rounds, our work in round three of TEAMS involved formative and summative evaluations of the exhibitions, participation in collaborative-wide meetings and professional development sessions, and in this case, a study of the research strand of this grant. Formative and summative studies of the exhibitions included naturalistic observations, mediated interviews, and exit interviews with visitors. In addition, we studied the ongoing growth and development of the collaborative, through participation in collaborative meetings and events, and through interviews with TEAMS staff members throughout the project.

This Report

This report highlights findings from the evaluation of the third round of TEAMS funding. Because the focal point of the collaborative's work centered on learning about how to design exhibits that promote conversation, and the application of that learning to the exhibitions being developed, the findings we will share in this report focus on two key areas: 1) a summary of the research project – i.e., the design of this focal area of work, and the larger lessons learned from the effort; and 2) a summary of the exhibitions – in particular, the quality of the resulting exhibitions vis a vis conversations.

RESEARCH PROJECT SUMMARY

Brief History of the TEAMS III Research Effort

In the proposal to NSF, one of the main goals of this round of funding was for TEAMS to “inform its design practice with socio-cultural research.” The proposed goals of the project were to:

- Further explore the influence of exhibit variables on patterns of family conversations, using existing and new TEAMS exhibitions;
- Explore how the research can be translated into a widely applicable set of design principles and concrete techniques to increase social interactions around the exhibitions;
- Refine and substantiate these principles through the TEAMS exhibit design and prototyping process; and
- Develop a set of guidelines for dissemination to the field that support design of exhibits that encourage beneficial learning conversations among visitors.²

¹ For more information about Inverness Research, please see our website at www.inverness-research.org.

² From the TEAMS Exhibition Collaborative proposal to the National Science Foundation.

Early on in this round of funding, the collaborative participants met with research advisors³ to discuss the overarching focus of the research work. After this meeting, the group decided to focus the research on conversations – specifically applying a socio-cultural learning lens to conversations at exhibits, and how to design exhibits such that the conversations that took place would promote learning. The bulk of the research would be conducted at the Montshire, because the project’s postdoctoral researcher, Dr. Leslie Atkins, would be working with nearby Dartmouth College. That work would then be shared with the other collaborative members. The hope was that out of this research, a tool or set of design criteria would be developed that would facilitate rich learning conversations at exhibits. Thus, there was an expectation that this research would take place ahead of the exhibit designs, and the researchers would share findings with the exhibit developers about what the research suggested about exhibit design.

Dr. Atkins conducted videotaping and analysis work at the Montshire, and later in the project, assisted staff from other collaborative museums in carrying out the research work at their institutions. At the Montshire, Dr. Atkins and museum staff began by videotaping visitors using several permanent exhibits. Videotape footage was coded for conversations, variables were changed, and additional filming was done and coded. Dr. Atkins explained her study to us in this way:

What I’m studying is how parents guide children into conversational patterns... there are ways of talking that you do in school that you have to learn. [We are looking at the] certain ways [of talking] that are scientific, that parents model for kids, and trying to figure out what are the patterns, are they useful, what cues exist that can promote the more fruitful patterns?

Having conversations lead to deeper understanding or engagement with phenomena is secondary. The important thing is the conversation itself...

During the intensive and iterative research process that took place over many months, Dr. Atkins and staff learned a great deal about how to improve existing exhibits to facilitate greater conversation. For example, they realized that in some cases, they as designers had been unclear as to what kinds of conversations would demonstrate successful learning experiences at the exhibits. They also realized that at the more open-ended exhibits, too much or too little label copy, and too much visitor interaction, were inhibiting the kinds of conversations they wanted to hear. The findings from this work were published in two papers by Dr. Atkins.⁴

³ The TEAMS III research advisors and project consultants were Maureen Callanan, Kevin Crowley, Kevin Dunbar, Sue Allen, and Leona Schauble.

⁴ Atkins, Leslie, et al. *The Unintended Effects of Interactive Objects and Labels in the Science Museum*. Science Education, 9 June 2008, pages 1-24; and Atkins, Leslie. *Frames and Games*

In June 2005, Dr. Atkins and Montshire staff shared what they had learned from their research work with the rest of the collaborative. A checklist tool was developed and tested on prototypes that collaborative members had brought to the TEAMS meeting. Several important findings emerged from this workshop. The first of these was that the process of viewing videotape and discussing the interactions and conversations visitors were having at exhibits was a valuable tool for fostering professional conversations among the collaborative community.

Secondly, the checklist tool did not work well with the early-stage prototypes: the prototypes were at such an early stage in their development that the basic navigational and conceptual pieces were not developed enough for visitors or designers to focus on the types of conversations taking place. That is, conversations tended to be about how to make the exhibit work. The checklist also seemed inadequate for documenting the complexity of what happens with visitors at an exhibit.

TEAMS collaborative members left this workshop with plans to engage in some trial of the research process at their institutions. Because of the complexity of the research work and the short timeframe in which they would be developing the round three exhibitions, they decided to select two or three key exhibits as they developed their TEAMS exhibitions around which to conduct research. They would videotape and then adjust the design of these prototypes to facilitate conversations. Dr. Atkins would assist as much as possible with the technical aspects – optimal set up of cameras and microphones – as well as with analysis.

Over the course of the exhibition development phase, exhibit developers at each of the TEAMS museums prototyped components, and to some extent, employed the strategies of the research to their focal exhibits. All of the museums engaged in videotaping at the focal components, and some of the museums employed Atkins' coding scheme to analyze visitor conversations.

As we conducted our formative evaluation site visits, Dr. Atkins joined us on several occasions, videotaping and coding at the focal exhibits and participating in debriefing sessions on the exhibitions. Prior to the second formative site visit, Inverness asked exhibit developers to write and share with us what they would consider "ideal" conversations at the focal exhibits. In addition to our general data gathering with visitors to inform the final exhibits, our goal was to record conversations at the focal components as literally as possible so that we could compare the "ideal" conversation with the ones visitors were actually having at these exhibits.

in the Science Museum: A Lens for Understanding Visitor Behavior. International Conference of the Learning Sciences, 2006.

In the summative evaluation, we focused our attention in particular on the extent to which visitors were, in the end, having at least some of these “ideal” conversations in each of the four exhibitions.

Benefits to Staff from the Research Project

Benefits to Montshire

Staff at the Montshire who worked most closely with the researcher on the project received the most benefit from this aspect of the project’s work. For Montshire staff, working closely with Dr. Atkins and Dr. Kevin Dunbar was a valuable experience. Having a researcher on the floor with them, doing research that benefited both the intellectual goals of pure research and the practical goals of exhibit design was a stimulating experience for the staff. Because the researchers and practitioners were working together, the practitioners were learning about research on learning that was informative, and the researchers were learning about what learning looks like in informal settings in a very firsthand and practical way. The immediacy of the experience – with researchers and exhibit designers working together in real time (rather than the researcher working in isolation and practitioners then drawing on her findings years later) – was an important reason this was a powerful experience for the Montshire staff. As one staff person said:

Everybody had a lot of respect for one another and we all met together – every meeting was exhibit staff and researchers together. And we as practitioners had certain ways of looking at the videotape and what was happening and the researchers had completely different ways of looking at it. So we were both learning from each other.

Taking existing exhibits that staff thought were fairly successful and applying this research lens to study visitors was an eye-opening experience for Montshire staff. They realized that they could learn a great deal more about what was and wasn’t happening at each exhibit using this approach. As the director noted,

You build these exhibits your whole career and you think you know something about what is going on. We started doing the videotaping and realized that there is stuff going on that we didn’t have any idea about, and when we looked at it through that lens, it was kind of obvious. There were people over here that weren’t saying a word... and over there, they were chatting up a storm. Why is that? Things that we thought were really good exhibits, when we looked at them through that lens, we realized people were totally confused. We just weren’t asking ourselves the right questions. So it was a very powerful experience and tool for us.

As a result of this experience, they modified several existing exhibits and hope to use this process to go back and make improvements to other exhibits on the

museum floor. They are also trying to streamline the approach to lessen the expense of it.

Doing the very deep, narrow analysis with the videotape and coding and looking for patterns... that is the really tough, expensive stuff. And we are finding that probably 80% of the learning we can do just by watching and talking about it together... so we are experimenting with a way to observe, count and record these things on Palm Pilots.

Benefits to Other TEAMS Staff

It is clear that working directly with the researcher on the floor of their museum was beneficial to Montshire staff. The TEAMS staff originally thought that the Montshire could do some of this work with the researcher early in the grant period, and then share design criteria with the rest of the collaborative. That did not happen due largely to the separate timelines of the research and the exhibit development process (we will discuss this in the lessons learned section of this report). Therefore, the other TEAMS staff did not have the same highly beneficial experience as the Montshire staff. However, the TEAMS collaborative staff outside of Montshire still benefited from the research in important ways.

- Learning the technical aspects of videotaping visitors

TEAMS collaborative staff learned a great deal about successful videotaping of visitors. They learned about the Institutional Review Board process, about the type of microphones that work best, how and where to place the camera, and how to let visitors know they are being videotaped. This in and of itself was a useful outcome for most staff.

- Using videotaping as a tool in formative evaluation

Several TEAMS staff members also valued having extensive videotape of visitors using exhibits to use as a formative evaluation tool. In particular, some staff thought they could skim through more recorded interactions than they could spend time on the floor observing, giving them a better grounding in the experience of visitors to base design decisions on.

I am hoping we can continue to do videotaping with prototyping, because that was a huge timesaver for me.

I'm very impressed by how much more I can get done using the video.

- Helping exhibit designers be more specific about visitor experiences

TEAMS staff reported benefiting from thinking about the ideal conversations they would like to hear at exhibits and comparing the actual conversations from

videotape and evaluation results. In some cases, they realized they needed to provide more support, experiences, and information to visitors in order to help them achieve those ideal conversations.

You had to go through the visitors' process with imagining an ideal conversation. We came up with the idea that we were asking too much of them.

- Developing a focal point and shared language around which the collaborative could do real work

As we have seen in previous rounds of NSF funding for the TEAMS collaborative, providing a common focal point is a beneficial strategy that allows the entire collaborative to engage in a shared study of their exhibit designs. Focusing on research about conversations was no exception. Like family learning and accessibility in the previous grants, designing for conversations became something exhibit designers had in the backs of their minds at all times. It helped the designers broaden their repertoire of tools and increased their strategies for helping produce positive learning experiences for visitors. It also created a shared experience around which all members of the collaborative could talk and learn together.

Impacts of the Research Project on Exhibits

The focus on conversations influenced the exhibit designs in this round of funding in several ways. Designers experimented with various interventions throughout the design process to enhance and encourage conversations. As one exhibit designer noted:

I am still experimenting with Let it Roll, as far as the objects being rolled, to see what encourages conversation and analysis that we want to see visitors doing...

Interventions included grouping exhibits to encourage visitors to make and express connections between concepts, and laying out multi-component exhibits in such a way that visitors could easily make comparisons between the various pieces. For example, in the Spin exhibit, designers worked to group components so that visitors could easily make connections between exhibits, and so that the concepts in the exhibits could be reinforced. As one exhibit designer said:

I do think there is something about location and surrounding exhibits and how that impacts the conversation. We had one exhibit that I would have kicked out, but because visitors were making connections between it and the one next to it, and having conversations about it, we kept it.

In the From Here to There exhibition, several components were designed in a plus-sign formation, with mini-exhibits on the end of each point. For example, in one exhibit, visitors could examine models of different types of motors and make comparisons about the motors' designs. This physical layout was designed to be conducive to visitors talking about exhibit content.

And in the best cases, we observed conversations that were close to the ideals expressed by designers. In the Exhibition Summary section of this report, we present vignettes that showcase the types of conversations we overheard at key components in the exhibitions.

Lessons Learned from the Research Project

The TEAMS Collaborative learned a great deal from their efforts to engage simultaneously in a research and exhibit design process.

- Research and exhibit development timeframes must be carefully staged, if the research is to be applied to the exhibit development process

Collaborative members originally thought that the research process would come first, and then the lessons learned from the research would inform the design of the exhibits. This was not realistic. Research, by its nature, is a slower process. In this instance, the timeframe for developing a traveling exhibition necessitated that the collaborative begin working on exhibits prior to the research data being released. Thus, the research and exhibit development happened more in parallel than sequentially. As one director noted:

We had this grand idea that we were going to select a couple of variables, run some experiments to test them, and use the results to inform the exhibit design process for the partnership groups in the Collaborative. We found pretty early on that the logistics weren't going to work. It took time to get a post-doc on board and then to get her up and running. And once a post-doc starts doing things, they don't want to share their raw data right away. We were willing to delay the exhibit development process a few months, but we couldn't wait a year.

While there were specific interventions that some designers found helpful in encouraging conversations, because of the mismatch in time frame, the research work did not as directly and thoroughly impact the development of the exhibitions as perhaps TEAMS directors initially thought it might. As one director noted:

In a sense, we did some good and interesting research that did have an effect on the way we all do our work, but it didn't directly feed into a process that was being used on the exhibits we developed for this round of TEAMS funding.

- Inadequate budget and no intentional strategy for researcher to work effectively with other collaborative members

As we stated earlier, Montshire staff gained the greatest benefit from interacting directly and frequently with Dr. Atkins. While other TEAMS staff benefited from the professional development workshop that Montshire and Dr. Atkins hosted for them, without the ongoing interactions, the research work did not have as great of an impact on the other collaborative staff.

- Exhibits have to be far along in their development for research to be most effective

Research on conversations worked best when prototypes were fairly advanced in their development. Navigation and invitation issues had to be resolved before conversations could be the focus of the work; otherwise, visitor conversations tended to focus on these things and not the conceptual ideas.

I think it certainly holds true that it needs to be a fairly well advanced prototype or even a finished exhibit where you want to go back and proof that exhibit before you can study conversations.

- This project did not lead to the creation of an explicit “tool” for exhibit design, but it did lead to a potential tool for staff development

A major proposed outcome of the project was that a tool or “checklist” could be developed which would be based on the research findings and which would guide exhibit developers to create experiences for visitors that encouraged desirable conversations about science. This turned out to be a naïve expectation. It proved to be almost impossible to pinpoint any single intervention (e.g., signage, layout, type of exhibit) that leads to better and more conversations at all exhibits all the time. Interventions instead had to be tailored to the individual exhibit. As one TEAMS collaborative staff member noted:

I learned [from this research work] that it's not so much “which variables” are most important, but rather “how can we better study those variables we think might be important for each particular exhibit.” In other words, we are learning a new technique for formative evaluation, rather than getting a list of design criteria as we originally thought we would get.

Perhaps most importantly, the viewing of videotaping and discussing the extent to which conversations are or are not happening among visitors by a group of staff proved to be a very powerful tool for staff development. During the Montshire workshop, when all TEAMS members were viewing videotape, the ensuing discussions about the visitor interactions were compelling.

The fact that you can look at tapes makes it not quite as easy to kid yourself about the visitor experience.

It does appear to be the kind of experience that changes the way you think about exhibits. We went into it thinking of this as a design tool, but I think in fact, it is a staff development tool.

Dr. Atkins noted the benefits to staff of this process in the following way:

[The process provided] another way of looking at exhibits, not just at the content, but how people talk about it. It gave exhibit developers the ability to look less at the nouns and more the structure of the conversation, one that values explanation, meaning making, etc., whether they related the proper phenomena or not.

One museum has begun to use videotapes collected during the TEAMS exhibit development research with education staff as a vehicle for training floor staff in evaluation observations.

One night I had 20 teens sit around a table and watch video of families using the exhibits. And it was fantastic. I asked them, “what are the kinds of things you are noticing?” The more we did it, the more they started to pick up on things. They really started to pick up on things to look for and now they are much more comfortable doing evaluation.

- Videotaping and focusing on conversations provide a useful way to “groundtruth” exhibits

What emerged from the research work and the focus on conversations was an improvement process for exhibits that involved three steps. The first step is to get a record of the designer’s stated intentions for the exhibit – by having the exhibit designer envision the best case usage of the exhibit and the types of conversations designers would ideally like to hear at the exhibit. The second part involves videotaping real interactions between visitors at the exhibit. By watching this, designers get firsthand experience learning about the way visitors are and aren’t interacting and conversing at their exhibit. The third step is to then look for the congruence between the idealized experience and conversation and the real ones reflected in the videotape. Exhibit designers can then create hypotheses about how to improve the experience and conversations for visitors so that the real experience and conversation comes closer to the idealized one. We experimented with this process during the course of the project and some exhibit developers found it to be useful. As one exhibit developer said:

Envisioning a conversation is a great exhibit development tool. I was writing an ideal conversation and running into all these stumbling blocks.

The stumbling blocks tell us where we need to re-design and improve the exhibit.

- Not every exhibit encourages conversation; conversation is one of many factors that contribute to good experiences for visitors.

Some exhibits were very engaging and clearly led visitors to positive interactions, but were not the types of exhibits that generated a great deal of conversation. TEAMS staff were satisfied that not every exhibit needed to generate a great deal of conversation in order to be considered successful. Certainly different styles of exhibits – and their different goals – have an affect on the amount and types of conversations that happen. In addition, the extent to which families normally talk with each other also carries over to their interactions at exhibits.

Some of the research that we did seemed to imply that some exhibits are more conducive to conversations than others. I think there are some exhibits that probably have less potential for conversation, but I wouldn't say they are bad exhibits.

You can't make conversations happen; you can only make it possible for them to happen.

Families are so different – you might have a family that normally converses with one another all the time, and you might have one that doesn't. If you have the latter, there isn't a lot you can do to make them talk to each other about the exhibit.

EXHIBITION SUMMARY

As we mention in our report on the return on the investment in the TEAMS Collaborative,⁵ we definitely saw improvement in the exhibitions over the course of three rounds of funding. Through the professional development provided by the project, feedback from their colleagues, feedback from visitors through formative evaluation efforts, and staff reflection on their work, the exhibitions progressed in quality. In general, the exhibitions all provide inquiry-based, engaging, in-depth experiences for visitors.

In fact, our summative evaluations of the four exhibitions developed in this round of funding were positive overall. All are highly representative of the philosophies and goals of the institutions that created them but also they reflected the collective learning and work of the collaborative. Each of the exhibitions contained exhibits that were highly effective and that contributed to lengthy, positive experiences for most visitors. In addition, we documented for each exhibition a wide range of ages engaging with these components and utilizing them effectively.

Because of the focus on the research project, we did not conduct a traditional summative evaluation of the exhibitions, but rather focused on documenting the impact of the research project on the exhibitions. That is, instead of the trackings and exit interviews that we would normally do for the summative, we focused on collecting conversations in the exhibitions, through naturalistic observations and mediated interviews at exhibits.

We share below highlights from each of the exhibitions. We chose these particular vignettes because we feel that they capture the kind of visitor behavior and conversation that TEAMS staff wanted to encourage through their design efforts. Some vignettes contain more conversations than others. For those that do, we see that they include some of the characteristics of scientific conversations and scientific sense-making identified by Dr. Atkins in her research, such as:

- defining terminology
- clarifying/elaborating
- suggesting possible experimentation
- sharing/providing observations
- making/providing predictions/hypotheses
- formulating explanations
- interpreting data/patterns
- relating evidence to explanations
- sharing experience from outside the museum

⁵ See: "Lessons Learned From the Long-term Investment in the TEAMS Collaborative." Inverness Research, Inc. 2008. (<http://www.inverness-research.org> or <http://www.informalscience.org>)

- expressing surprise and articulating rationale for that surprise

For more complete summaries of the findings from the summative evaluations on each of the individual exhibitions, please see the appendix.

Vignettes of Exhibit Usage

Vignette from Montshire's Toys Exhibition: Grandma, grandpa, mom, dad, 5 year old boy and toddler girl at the Pulley table

The Pulley Table exhibit consists of table tops at two heights at which visitors can experiment with a variety of pulleys. There are single and stacked pulleys, and pulleys of various sizes which visitors can connect using elastic bands and then turn.

This vignette demonstrates a family interaction at a fairly open-ended exhibit. It demonstrates the depth of experience and conversations families can have at this exhibit. It also demonstrates the connections visitors were routinely making between components in this exhibition.

The boy approaches the exhibit first and immediately starts to remove rubber bands and move pulleys around. Grandma tells him he should read the label, but the boy ignores her. The mom and rest of the family join them. Mom: "What's this? It's like the gear table over there, isn't it." The mom and boy begin working on their own individual experiments – the mom is trying to hook pulleys together to make one of the pattern pulleys spin, and the boy is trying to hook a rubber band diagonally from the lower table to the upper table. Mom: "This is cool. Look what this does to this pattern." Boy: "I know." Boy: "Mommy, wait. I got an idea! Connect these before the other one!" Now the mom, grandma and boy are all working together trying to connect up a series of pattern pulleys on the top table to get them all to spin. Mom: "I am trying to get see how far away I can put a pulley and make it spin fast. Ok, we've connected that one to that one. It seems like it has to do with whether the rubber band is stretchy or not." They trade out rubber bands. They all work on the boy's experiment of connecting the pulleys at an angle. The boy then returns to the top table. Boy: "These two go really fast! I know the science! I have a prediction! These go really fast but those go slower. Those are different sets on the top!" Mom reads the label aloud: "To turn something slowly, use a small pulley to turn a bigger one. To turn something fast, use a big pulley to turn a smaller one. Remember the gears on the other side of the room? The big gear to little gear? I wonder if it is the same concept?"

Vignette from the From Here to There exhibition: Mom and two year old son at the Feel the Friction exhibit

This exhibit consists of three connected bins set up like spokes. One bin contains a car and a bumpy dirt road to run it on; another a train track and train car; and the third contains water and a boat. Visitors can experiment with how the different vehicles and surfaces interact.

This vignette demonstrates experimentation by a two year old with the phenomenon of friction at this exhibit.

A two and a half year old boy and his mom came to this exhibit and spent about 15 minutes playing with it. The mom pulled up a stool a small distance away and let her son explore. He started with the train, pushing the train car back and forth. Then he noticed the handles on the tops of the weights. He picked up the weight from the train, then the weight from the dirt car and held them and looked at them. He then put the weights back on the cars and pushed first the train, and then the dirt car. Then he moved to the boat and pushed it back and forth. He added a weight to the boat and attempted to push it, then moved the weight back to the train. Then he came back to between the dirt and train sections. He pushed them both on their own again, then picked up the train car and put it in with the dirt car and pushed them both on the dirt. Then he picked the cars up and put them both on the train track and pushed them both on the track. He then placed the boat on the track with the other two and pushed on all three. He moved the boat back to the water and tried to put the train car in the water; his mom intervened and told him those cars needed to be kept dry. At one point when the two cars were on the train track, the mom said: "Look, it's bumpy. Bump, bump, bump." He repeated all of these activities at least twice and sometimes three times. When an older boy approached the dirt car at one point, he raced over and put his hand on the weight and the older boy moved on. The boy continued to experiment until his mom said: "Let's go look at a new one" and they moved on.

Vignette from the Get the Message exhibition: a mom and two seven year old girls at the Crane exhibit

This exhibit consists of a large crane. The crane operator cannot see over a barricade the two places (a bin on one side and truck on the other) in which to place the load that is attached to the crane. Visitors work together, with one person out front directing the crane operator through hand signals of where and how to move the load.

This vignette demonstrates family usage of this popular component. It demonstrates how the family worked and communicated together to be successful.

A mom with two seven year old girls use this exhibit. The girls start using it on their own at first while mom finishes looking at another exhibit. One girl enters the cab and calls her friend over. As she looks for the load, she asks, "Where is it?" One girl runs around the front, finds it, then comes back. "It is right over there!" Both inside the cab, they work together to raise the load. "Watch out!" They laugh. Mom approaches, sees the labels on the front, and directs the girls to "put the load in the red box." The first girl asks, "Where's the red box?" Mom points to it and uses her hand to gesture the girls to move the load further to their left. Then she points down and the girls lower the load into the box. Mom scoots the box with her foot so it is a perfect fit. The second girl says, "Let's go see!" They race around the front, take a quick look, then run back into the cab. Mom makes the lift gesture with her hand, and the girls raise the load. Mom gestures to them to move the load to their right, toward the truck. As the load moves, Mom moves with it. The girls tell her to move to the side. At the truck, Mom gestures to the girls to lower the load, then makes the "stop" gesture when it is down. As they lower the load into the truck, one girl says, "going down into the blue truck! Let's go see!" Once again, they run around to check out how they have done. Then it is back to the cab to raise the load again. Mom points to their left again and one of the girls runs out to join mom in the signaling department. As the mom and girl give directions through hand signals, the other girl moves the load and lowers it into the red box. Then it is back to the truck, with the mom and girl giving hand signals. After they get it into the back of the truck, the one girl raises the load and puts it down on top of the cab of the truck. They all laugh. The girl raises the load, the mom signals stop and points to the right. The girl lowers it into the back of the truck again and they all leave to let other kids have their turn.

Vignette of Spin exhibition: A four year old girl, her six year old sister, and their dad at the Racing Rollers exhibit

The Racing Rollers exhibit consists of parallel tracks with wheels on them. The track sections are of varying widths and correspond to different widths of wheel sizes on the wheels. Visitors can experiment with different track set-ups the relationship between the width of the track and the size of the wheels.

This vignette demonstrates a family interaction and experimentation at Racing Rollers.

A four year old girl and her six year old sister used this exhibit with their dad. The four year old begins using this by herself at first, rolling one of the rollers up the track, pushing it up as high as she could and letting go. She does this again as her dad approaches and says, "Watch your fingers!" She rolls both wheels up and lets them go. Dad says, "Why do you think that it goes so much slower on this part?" The girl says,

“Because I am doing this!” and she shows him how hard she is pushing off on one of the rollers. The dad says, “Try doing that on this side and see if it does the same thing.” The six year old joins them at this point, asking, “Want to do them at the same time to see which one goes the farthest?” The dad reads the label to himself while the girls launch the rollers. Dad says, “Look at which wheel is touching the track there. You can move the track pieces.” He changes one piece of track around, saying, “Let’s see what happens.” They launch the rollers, then rearrange the tracks again. They launch the rollers again, and this time, notice the difference between the fast and slowest tracks. Dad says, “That was neat!” The four year old girl says, “I love this game!” The girls start rolling the rollers, pushing them as fast as they can with their hands while they roll. “Vooma kabooma!” the four year old says. Dad says, “We should build one. Have you figured out what makes it go fast and slow?” The six year old says, “The two parts have to be together.” They leave for the Air Thrusters exhibit after using Racing Rollers for over five minutes.

SUMMARY

In its third round of funding, the TEAMS Collaborative continued to build on the successes and learning from the previous two rounds of NSF funding. The focus on research into conversations built naturally from the work in previous rounds on accessibility and family learning. The thematic approach, this time focusing on conversations, facilitated the staff of the collaborating museums to continue to build their capacity to develop effective exhibits. The Collaborative also created four high-quality traveling exhibitions designed for small museums, helping to alleviate the need in the field for high quality traveling exhibitions designed specifically for small spaces.

In a sense, the TEAMS group in this round of funding was trying to do three complex and challenging projects at the same time: 1) to work together in dyad partnerships within the larger collaborative; 2) to develop traveling exhibitions; and 3) to conduct a research study. There simply wasn't the time or funding to adequately do all three, and the focus quickly, and we think correctly, turned to developing the best exhibitions they could in the time they had while working as much as possible on the research strand. It would have been ideal if there had been more opportunity for collaborative staff to come together and work collectively with Dr. Atkins and the research advisors to share their processes and findings around designing for conversations.

However, there were still important and beneficial contributions of the research project to collaborative members. TEAMS staff are now more aware that the nature of visitors' conversations is something interesting and important to pay attention to. In addition, staff are now having more of their own conversations about what it means for visitors to have good experiences with science, and how that is reflected in the way visitors talk around the exhibits.

In general, the research work in this round of funding has exposed TEAMS museum staff to another dimension of the exhibit prototyping and improvement process. For some, the process of videotaping and examining carefully how visitors actually use the exhibits and talk about them has been transformational – exhibits they thought were very good turn out not to provide the kind of experience that the designers intended. For these designers, conversations – and the degree to which the types of conversations at exhibits are indicators of the types of learning occurring there – have taken on a new level of importance in the design work they do.

No concrete "tool" or checklist for how to design exhibits to facilitate conversations emerged from this work as was originally hoped for. However, what did emerge was an important process for exhibit developers to become clearer about envisioning the ideal interactions and conversations they want visitors to have at specific exhibits, and to become more grounded in the reality of what is happening at specific exhibits. While it isn't practical or feasible for

museums to conduct rigorous research on conversations and code the data as they develop most exhibits, it is feasible to work through this process of groundtruthing in a way that results in better exhibits and better conversations for visitors.

Appendix A
TEAMS Summative Evaluation
Site Visit Memos

This appendix contains Inverness Research's informal memos we prepared following our summative site visits to each of the exhibitions. We conducted the evaluations at the home institutions of the exhibitions. These memos were intended for internal use by museum staff only, and were designed to provide remedial feedback to exhibit developers so that they could fine-tune the exhibits before they began to travel. In addition, the memos were designed to provide documentation of visitor conversations at key exhibits.

TEAMS

Conversation, Visitor Experience and Learning Vignettes

Inverness Research Summative Site Visit:

Toys: The Inside Story

(Montshire Museum of Science)

May 12-13, 2007

Numbers and demographics of visitors

Lynn's numbers of visitors observed and interviewed:

-Observations: approximately 40-50 visitors*

-Observed and made notes about: 31 visitors usually in pairs or three's

* If I saw the same behavior happening as with the 31 visitors I observed and made notes about, I did not make any notes.

Interviewed: included in 31 visitors above:

-Father and 10-year old male

-Mother with boy age 5 and girl age 3

-Mother with boy age 10

-Mother with two girls, ages 2 and 5

-Mother with boy in 4th grade (both looked to be partially African American – only African Americans I saw in the exhibition)

-Mother with boy age 11

-Girl age 12

-Two girls approximately age 14

-Adult male

Becky's number of visitor groups observed in the exhibition: 44

Number of visitors interviewed (included in the 44 above): 16

Father and 6 year old male child, three year old female child

Father and five year old male child and three year old female child

Father and four year old male child

Mother and five year old male child

Mother and thirteen year old female child

Father and seven year old male child

Mother and four year old female child

Highlights from interviews and observations

- Adult and children said that the exhibit was about “how toys worked,” “what’s inside toys,” “about gears and pulley.”
- Many adults read the wall signs – we think because the exhibits are incorporated into the walls, the signage gets read; we also think it had to do with the large number of parents visiting with quite small children who were reading the signs aloud to their children.

- Several adults directed their children's attention to the videos that showed the inner mechanisms of some of the toys.
 - o Adult male said the video at the Jack in the Box was the most useful modality there for illustrating how the toy works.
- Children in elementary school and older know instinctively what to do at the Pulley Table – move bands, move wheels, connect bands to wheels.
- Children set up challenges for themselves at Pulley and Gear Tables.
- Male visitors especially spend time at the Pulley Table and Gear Table.
- The word “pulley” was familiar to children in upper elementary and older.
- The word “cam” was not as familiar to children of all ages and some adults, so there was the impression that these visitors may have learned what a cam was:
 - o Girl age 12 did not know what cam meant but when asked what cams do said, “they make things move.”
 - o There were also several visitors we observed who would use the cam, then lift the object or complete the circuit with their fingers.
- A father with a 10-year old male said that they knew about pulleys from being in scouts where they use pulleys to lift things. An 11-year old visitor said he knew about pulleys from studying history where pulleys were used to move big limestone blocks. Two examples of a connection to block-and-tackle being made.
- “Love it!” “Great exhibit!” “There’s more for kids to do than just push buttons,” mother with boy age 5 and girl age 3. She said she will tell the 5-year old’s teacher about the exhibit and take her the Family Activity cards so that the teacher can prepare the class for their upcoming field trip to the Montshire.
- Many adult visitors expressed nostalgia about some of the exhibit components – Operation, the Etch-a-Sketch and Mr. Machine in particular.
- We observed many examples of visitors making connections between exhibits, and making connections between the exhibits and their daily life; see specific examples in the vignettes section that follows this one.
- The exhibition generated sounds of satisfaction and success – many times in the exhibit hall, we overheard visitors’ comments such as, “Yes!” “We did it!” “Oh! That’s like this!”
- We saw several examples where moms and dads got immersed in the gears or the pulleys and wanted to continue using the exhibits after their children had moved on.
- 13 year old girl: “I found out a lot of things that are inside toys that I didn’t know was there.”
- Mom: “I never understood how a circuit worked before! I liked how this got some science and engineering down to the level of younger kids.”
- Father with six year old boy and three year old girl: “We live in Montpelier and we usually come to the museum in the winter, but we came to the museum to see the toys exhibit.” Boy: “We wanted to know what was inside toys!” I asked the dad to comment on the gears exhibit: “You see how quickly he figured out he needed a different size gear and to put things in a different hole. The gears are pretty great.”

“Conversation” types

- Parents reading signs to children.
- Parents encouraging children and children encouraging parents to observe:
 - Adult female to children ages 3 and 5 when the adult changed bands on the Pulley Table: “Now, let’s see what happens.” Children’s response: “Yea!”
 - Same adult and children when viewing the Etch-A-Sketch on the Pulley Wall: “Now you get to see what’s inside of it.”
 - Several examples of children saying “Look” or “Watch” at Pulley Table.
- Pairs of visitors telling each other how to manipulate an exhibit
 - Two girls ages about 14 at the Etch-A-Sketch Pattern Tracer: “At the same time, 1,2,3”
- Parents asking children how they made something happen:
 - Boy age 11 to mother at Pulley Table “See what I did?” “I can make the this (Bird in Cage piece) go really fast.” Mom: “How did you do that?” Boy: “I moved the wheel closer.”
- Vocal responses– while these were not conversations, they were vocal responses that were motivated by an exhibit:
 - Parent calling child and child calling parent to come to an exhibit:
Male child age 5 referring to “Operation” game: “Daddy, want to hear the noise?”
 - Satisfaction, amazement
Boy in 4th grade: “Cool, I never knew how an Etch-A-Sketch worked.”
 - Whistling the Mr. Machine commercial tune
- One-way, parent to young child conversation:

Mom to toddler son at the Jack in the Box exhibit:

“So all these pictures show you what happens on the inside. This one shows you how it works. This one shows you how the music box works. You can even see it up here on the TV. See how all the little bars lift up?”

Mom with toddler son and daughter at Jack in the Box:

“You can see how this big huge spring allows the toy to pop up and down. That’s pretty interesting! See this one is showing you how the clown pops out!”

Mom with toddler son at Elmo:

“They are showing you Elmo – they took him apart to show you where the noise comes from and where the movement comes from. Over here, there are circuits that make things happen.”

Mom with two female children at Linkages:

“See how it is connected? It’s like points. Like how your arms is connected and moves. Remember the piggy you had that grandpa fixed for you? See all the points where it is all connected? See, it is showing you how it works.”

- Examples of more two-way conversations:

Mom and son at Cam Wall:

Mom: “Why is your frog jumping so much higher than my frog?”

Son: “I don’t know.”

Mom: “See how the circle is in the middle of this one? See how the screw is higher here on this one? So there’s more space here and it makes this one go up higher.”

Mom at firefly: “See that piece of metal? It is connecting. It is making a connection.”

Mom and 5 year old son at Cam Wall:

They work their way down the wall, starting with Dr. Duck on the right and working their way to the left and then back again to the right. Mom: “What is a cam? These things are called a cam – the part that turns on a shaft. They make things go.” She points to an orange cam at the frogs. “Do you remember, Charlie, what these things are called?” Son at firefly: “It is a cam. It is hitting this battery and making it light up.” Mom: “I bet if we took apart some of your toys at home we would find these inside.”

Dad with 6 year old boy at Piggy:

Boy: “Look at that cute piggy!”

Dad: “It is showing you how it works.”

Boy: “And look, here’s a model of the piggy.”

- Experience/Learning/Connections between Exhibits Vignettes:

7 year old boy at the Cam Wall:

He starts at the right hand side of the cam wall, closing the switch with his finger, then closing the switch with the cam. He works his way down the wall, from right to left, rotating each cam and reading the labels. At the woodchucks, he turns

the cams, then uses his fingers to make the wood chuck on the right to go up and down. He ends with the frogs, then moves on to the Gear Train exhibit.

Dad and 8 year old son at Pulley Wall:

Boy is at tortoise and hare: "What is this supposed to do?"

Dad is at the pulley challenge, immersed in activity: "Read it."

Boy: "Hares are fast."

As the dad continues to experiment with the pulley challenge, the boy works his way through the pulley exhibits until he meets up with dad.

Dad: "This one always spins at the same speed. So when you have a big wheel spinning a small wheel... If you want to spin it slower, you go small to big."

Dad and son go back to tortoise and hare exhibit. Dad: "This is all part of the same thing. This goes big to small and this goes from small to big."

Mom, Dad and 7 year old son at Circuits:

The mom and son start at the Eye of the Storm exhibit, then they move to Hello Kitty. The mom shows the son how to work the exhibit, saying, "complete the circuit." At the rod challenge, the mom tries it first. When the buzzer goes off, she says, "I didn't touch that! You try it!" The boy tried it and did it successfully. Mom: "You did it? I can't do it!" They all move to the complete the circuit table exhibit. At the simple exhibit, the boy gets the red light to come on after first pushing on the red light instead of completing the circuit. All three move to the exhibit on the right. Working together, they get the fan to come on. "Have we gotten that one yet?" the mom asks, pointing to the green light. "Follow the green line. Hold that switch down too." They get all four to go by working together. "Connect the red to the blue! Connect the red to the blue!"

Mom, dad and 8 year old girl at Circuits:

They use the complete the circuit exhibit together, trying to get each individual thing to come on at first, and then trying to get them all to come on. Mom says, "How do you think you can get this one to come on?" They try things, and dad says, "No, this one!" The girl says, "Hit that one again, Mom." Dad says, "Did you see that? She connected that around. Let's figure out how to make this one go." They get them all to come on. Mom says, "Oh, nicely done!" They move to Operation. Mom says, "Oh, I used to love this game!" The dad says he has never played it and mom explains the game to the dad and girl. Dad says, "It is the same idea as over there – it makes a loop for the electricity to flow through."

5 year old girl at Operation:

This girl held the tweezers in her hand and methodically ran the tweezers up and down the game board, very slowly, studying why there is a noise sometimes and not at others. She works her way down the rest of the circuit wall, getting Hello

Kitty to talk and trying the circuit challenge, before returning to the Operation game. She studies the picture of the game and the game itself, then tries to use the tweezers to lift something off the picture.

Dad with 9 year old son at Complete the Circuit:

Boy: "What do you do?"

Dad: "You have to complete the circuit. Each one starts and ends at the power source. Each one has to start from here (pointing to the power source) and go back to it." The two experiment; the boy sticks his fingers in the fan, dad frowns. They get three going and study to see how to get the fourth going. Dad gets the extra wire from the simple circuit exhibit and they get all four going. Boy: "We finished! One, two, three four! We did it!" Dad: "Nice!"

Dad with 6 year old boy and 3 year old girl at Gears:

Dad: "Oh, it's the Toy exhibit! Fun!" They approach the gear table. "See, you turn this one and it is turning all of them." The boy picks up a gear that is not attached to the table. Dad: "You can build things!" The dad studies the Mr. Machine video while the boy connects up the gears. Boy: "Daddy, look!" Dad: "Oh, you set it up a different way!" The both move to the other side of the gear table and start making another arrangement. Dad: "Let's get a bigger gear. You know how this works. See if you can make her dance." The boy gets one of the ballerina dolls spinning. Dad: "Whoa! These gears are cool." The girl, who had been at Elmo, sees the doll spinning and joins them at the gear table. They start all working together to try to connect from the low table up to the carousel. Dad: "Oh, it's not going to work. See?" They keep trying. Dad: "I have a suggestion." He tries a gear. "Nope, too close." The boy keeps trying. Boy: "Now all I need is a tiny one!" Dad: "Yeah, but the holes are blocked." They finally give up on their challenge and attach a drive gear to one side of the carousel and a ballerina doll to the other and the boy spins it fast. Dad: "Wow! That is so wonderful! She is really spinning!" The boy notices the other doll. "Please try that doll, papa." The dad connects up the other ballerina. The little girl puts her face down close to the dolls' skirts as they spin, feeling the fabric on her face and flipping the skirts up with her hands, giggling. Boy: "Look at her go! The things on the merry go round better hold on tight!" The boy stops interacting with the gears to watch the Mr. Machine commercial video. Then he turns back to the gears and starts gathering all of them. He begins to connect gears and calls his dad over, "Let me show you something, dad." He and the dad and the little girl work together and successfully connect from the lower left table up around to the carousel – what they wanted to do.

Grandma, grandpa, mom, dad, 5 year old boy and toddler girl at Pulley table:

The boy approaches the exhibit first and immediately starts to remove rubber bands and move pulleys around. Grandma tells him he should read the label

and is upset with him, but the boy just ignores him. The mom and rest of the family join them. Mom: "What's this? It's like the gear table over there, isn't it." The mom and boy begin working on their own individual experiments – the mom is trying to hook pulleys together to make one of the pattern pulleys spin, and the boy is trying to hook a rubber band diagonally from the lower table to the upper table. Mom: "This is cool what this does to this pattern." Boy: "I know." Boy: "Mommy, wait. I got an idea! Connect these before the other one!" Now the mom, grandma and boy are all working together trying to connect up a series of pattern pulleys on the top table to get them all to spin. Mom: "I am trying to get see how far away I can put a pulley and make it spin fast. Ok, we've connected that one to that one. It seems like it has to do with whether the rubber band is stretchy or not." They trade out rubber bands. They all work on the boy's experiment of connecting the pulleys at an angle. The boy then returns to the top table. Boy: "These two go really fast! I know the science! I have a prediction! These go really fast but those go slower. Those are different sets on the top!" Mom reads the label aloud: "to turn something slowly, use a small pulley to turn a bigger one. To turn something fast, use a big pulley to turn a smaller one. Remember the gears on the other side of the room? The big gear to little gear? I wonder if it is the same concept?"

Mom with thirteen year old daughter at the Pulley section:

Mom sits down and reads the label while the girl starts turning the knobs. They go to the Etch-a-Sketch on the pulley wall. Mom reads the label and then points back to the Giant Pulley Table: "This is like that over there! Oh!" She and her daughter then go to the pulley challenge and they take all the belts off. They connect one belt and push the button, then connect the rest of the belts. Mom: "Go from smaller to bigger and then from smaller to bigger again. Then go from bigger to smaller and compare the numbers. It goes much faster, doesn't it?" As they work their way down the pulley wall, the mom says, "That's what a stacked pulley is." Girl: "I liked seeing how the etch-a-sketch works." Mom: "She had studied pulleys in sixth grade. I didn't know there were pulleys in an etch-a-sketch. I finally understand some of what I had been quizzing her on in the car."

A 10 year old boy at Jack in the Box:

He used all three Jack-in-the-Boxes without noticing the video screen. As he was leaving the exhibit, he noticed the screen and went back to the exhibit and spent more time with the Jack in the Box with the video camera attached.

25 June 2007

TO: Directors and staff, TEAMS New York Partnership
Rochester Museum of Science and the Sciencenter

FROM: Becky Carroll and Dawn Huntwork
Inverness Research Associates

RE: *From Here to There* Summative Evaluation: Notes from site visit June 1-2,
2007

CC: Lynn Stelmah, Mark St. John (IRA)

Introduction and This Memo

Becky Carroll and Dawn Huntwork of Inverness Research Associates visited the Sciencenter in Ithaca, NY on June 1st and 2nd, 2007 in order to conduct a summative evaluation of the TEAMS *From Here To There* exhibition. We also conducted a summative interview with Charlie Trautmann (director), and a focus group interview with core TEAMS staff (Tom Prendergast, Kathy Krafft, Calvin Uzelmeier, and Rich Smith).

The general purpose of this memo is to provide feedback to core staff about the visitors' experience of the exhibition. Our feedback focuses specifically on three areas:

- the visitor experience of the exhibition as a whole;
- observations about and examples of the kinds of conversations that visitors had in the exhibition: we focused on this because of the "conversations" theme of this TEAMS grant; and
- component-specific feedback: this section is intended to inform remedial changes before the exhibition travels to other TEAMS museums.

We will use the information we learned from our director and staff interviews to inform our final summative report about the overall TEAMS project.

Demographics and Numbers of Visitors Observed

We observed the following numbers and demographics of visitors:

- 113 groups total, which included approximately 243 visitors. Of these, the visitors included:
 - 52 women
 - 33 men
 - 1 female teen
 - 2 male teens
 - 90 boys
 - 62 girls
 - 3 toddlers whose gender we could not identify

On the first day of our visit we observed several school groups of 1st and 3rd graders with their teachers and chaperones; on the second day visitors were primarily families with children from toddler to age 10-12, and some adult general-public visitors.

Observations and Feedback About the Exhibition as a Whole

- This exhibition is attractive to people of all ages, and the exhibits and phenomena are compelling for people with a range of interests. We can see that the design team made a conscious effort to focus on this, and they were successful. We saw many examples of every kind of interaction TEAMS staff might hope for: i.e., child-to-child, sibling-to-sibling, and adult-to-child. People came and stayed for quite some time; we also saw cases of visitors returning to the exhibition after spending time elsewhere in the museum.
- We noticed that there was an absence of negative behaviors; visitors did not seem bored, distracted, or disinterested in the exhibition.
- People did, with a few exceptions, everything they were “supposed” to do, which implies that, for the most part, the navigation of the exhibits is clear and fine-tuned.
- The organizing theme of the exhibition turned out to be broad enough to be able to include basic physics concepts (e.g., mechanical advantage, friction) while providing kinetic and intellectual experiences of “getting things from here to there” (e.g., how to use air pressure to move things; the relative advantage of using water vs. land to move things).
- We noticed that most of the components did get used. That is, we didn’t see any particular exhibit “orphaned” with the minor exception of *Wing Thing*.
- The titles of the exhibits lead to and reflect the basic experience/phenomena. (e.g., Feel Friction). This seemed to work well for visitors who don’t or can’t read very much to be able to get the basic idea of the exhibits.
- We noted particular exhibits where the attention to prototyping and conversations paid off in terms of the visitor experience. For example:

Hovercraft: We speculate that the T-design makes people think they are moving around a lot more than they are, which they like. There is an element of surprise

– i.e., that it holds people’s weight – and that visitors are experiencing a science concept – “that air can hold me up” – is very satisfying for visitors of all ages.

Air Tubes: The layout of the two stations of this exhibit supported interactions that held people’s attention, and allowed them to talk to each other in a way that helps facilitate what is interesting about that exhibit. Visitors were experimenting a lot to change the affect of air, and spent quite a bit of time at the exhibit.

- Cross-shaped layout experiment: Staff experimented with putting sub-components of an individual exhibit in a cross-shaped layout. We understand the idea of this approach was to try to facilitate conversation and to help visitors make connections between sub-components. This strategy worked well in some cases and not in others. It worked well at *Give It a Lift*. We noticed that because of this layout, visitors can see almost everything there is to do at this exhibit, and there is enough similarity between activities that it made visitors want to try all four sub-components and make comparisons. We noticed this at *Feel Friction* as well. The layout doesn’t seem to work as well at *Start Your Engines* – we speculate that this is because of the size of the models -- they are far away from each other, and visitors can only see the phenomenon from the front (therefore they can’t compare the different kinds of combustion engines and their parts). Also, this particular layout for this exhibit creates a lot of unused table space. We did notice that people do, indeed, want to look at each engine model and compare but were not able to do so easily; this is a case where components lined up closely might work better.
- Labels: Given the lengthy labels at several components, we recommend that designers step back and ask themselves: ‘What are one of two things that visitors need to know in order to operate the exhibit? What are only one or two things that would help them understand what they are experiencing?’ We think this amount of information would be enough for the typically 30-second to 2-minute time that visitors spend on a given component. We understand that that was the intention underlying the “layering” of signage, but what is there may still be too much – in general, people don’t seem to be reading the labels. However, if there are political constraints (e.g., with scientists/board members who feel strongly about including particular science content), it is probably okay to leave those longer sections.

Conversations

In this section we provide examples of “vignettes” – i.e., conversations and/or situations – that we feel reflect the goals of the TEAMS project, as well as vignettes that show areas that could be improved.

Earthmovers

The most common behavior at this exhibit is the use of the incline plane and pulley/bucket to move balls around. The trucks are used less, but sometimes, at the bottom of the incline plane. We saw two uses of balls as bearings (one with a boy moving his body around on the balls, and another of a boy moving the incline plane on the balls). Taking out about one-half of the balls made for a better experience in terms

of “moving things from here to there,” in that kids weren’t forced to walk/fall on the balls, but there were still enough to go around for at least 3 to 4 children using the exhibit at the same time.

Vignettes:

- Teacher to 3rd grade girls: “I think this has to do with simple machines. You’ve been studying them in school. What simple machine is that? Remember ‘incline plane’? You can see it on the wall, types of simple machines.” Girl points to truck: “That’s a wheel and axle.”
- Group of teachers walk up, read sign. Boy asks: “What’s a pulley?”
- Woman to two 2nd-grade boys: “These are the different ways to move things – how you can move sand and dirt…”
- Woman to two boys about first grade: “Use the pulley…” Boy uses incline plane to send balls into truck, then bucket. Boy: “It’s like a cement thing.”
- Mom to toddler: “What do you do with this pulley? It goes up, it goes down.”

Mag Lev

We observed people pushing and pulling the train across the track, pushing it down towards the track, and picking it up and looking underneath at magnets.

- 9 year-old boy, to researcher: “I know how this works - there’s magnets and they are either north and north or south and south, so they push the car up.”

Waterways

Conversations here were primarily of two types: instructional/navigational (“how does this work?”), and comparison to experience outside the museum (“this is like the Panama Canal”).

- Vignette: A man with a baby in a stroller and a girl about 5 years old approach the exhibit. Dad reads the beginning of the label, then sits down and says, “let’s try.” The girl plays with opening and closing the gates by hand. Dad to girl: “How do we get our boat from here to there? Watch the water, down there.” Dad opens lower gate. Dad to self: “Oh I see you have to have an equalizer.” Girl says to dad: “let’s go over there” (to another exhibit), but dad replies: “I’m going to beat this thing!” As he read through the instructions he became less clear about what to do; we approached him and he said, “the sentence in step one is confusing so I feel like I missed the whole thing. If there was a diagram at the beginning I wouldn’t need a four-part explanation.” Then, he says to the girl: “It’s like an elevator for boats!”

Up, Up and Away (Hot Air Balloon)

- Conversations here involved two types: the adult reading the labels or parts of the labels aloud to the kids while they watched the hot air balloon; and comments of awe

and excitement when the balloon rises. “There it goes!” “Oh m gosh, it does go up!” “Look! It’s going up!”

- One six year old boy using the exhibit told me: “You push the button and it gets hot air in it. Then it goes up. There was a hot air balloon flew right by my house once. It takes awhile, but that’s ok.”

Give It a Lift

- Conversations here mostly were operational in nature (“try this”) or were related to how easy or how hard things were to lift: “That’s easy!” “Wow, that’s heavy!” “You are a muscle man!” Several adults recognized the jack and related it to jacking up their car and this does lead to some conversations between adults and children about this. Adult female to male child: “That makes it real easy – like jacking up a car!”
- People are saying the words here – lever, hydraulics, pneumatics, pulleys.

Rocket Force

- Conversations here tend to focus on the procedural aspects of the exhibit – counting out the number of pumps; who gets to press the button and when the button should be pressed; and whose turn it is to do what.
- Vignette: One 9 year old girl I observed was carefully counting out the number of pumps out loud. The first time, she went to 34; the next 18; then 34 again; then 18 again twice. “When I pumped 34 times it went fast; when I pumped 18 it went slow. Those were just numbers I picked in my head.” She seemed very satisfied with her interaction with this exhibit.

Hovercraft

- Vignette: A three year old boy approached the exhibit with his dad. He sat in the chair. Dad: “Are you ready?” Boy: “Yeah!” Dad hits the on button and says “It is hovering!” The boy said, “It is?” Dad said: “It is!” The boy scoots himself around until his mom called him over to Up, Up and Away.
- Vignette: A mom starts out at the small hover craft. She turns it on, presses on it and moves it around, then picks it up and looks underneath. Her young adult male son approaches and uses the small hovercraft after his mom moves on; he also picks up the small hovercraft and looks underneath it. Then he notices the big hovercraft and calls his mom over. “Mom, have you seen one of these?” Mom joins him. “Have a seat, mom.” Mom: “Why? What are you going to do to me?” “Just have a seat.” She does and he turns it on and pushes her off with his foot. She says: “That’s cool!” Mom gets off and her other son, twelve, joins his brother at the exhibit. He says: “That’s cool!” The older boy said: “Hop on.” He does and the

older boy turns on the exhibit. "Try to center yourself on the seat. Lean forward a bit." The younger boy shifts his weight and scoots around. He says; "We should make one of these." The younger boy gets off and the older one gets on. The younger one said: "That's awesome!" After the older boy takes his turn, he turns it off, gets off, and looks underneath the big one.

Pneumatic Tubes

- Vignette: A three year old boy ran up to the tube on the left and told his dad: "You have to be on the other side! You have to be on the other side!" The boy sends two balls to his dad at the other station. Dad: "How did they do that?" He looks around as he sends the balls back through and follows the path of the balls. "Air tubes! That's how they do the money!" The boy sends the balls back to his dad and dad sends them back. "Here they come!" The boy sends them back, and dad sends one ball back and follows its path. The boy is waiting for the other ball. "Send the other one daddy!" Dad: "Ok, there it is." Boy: "Put it right in there, in that little hole." This time the boy follows the ball with his eyes and watches as it comes out on his dad's side. Dad: "That's fast, isn't it!" The boy pushes the ball up inside the outlet hole and it pops out into the bin. Then he puts both balls in the inlet as fast as he can, one right after the other. Dad sends the balls back, and this time, the boy tries to put both in at the same time. When that doesn't work, he sends them both again one after the other quickly.

Feel the Friction

- Vignette: A two and a half year old boy and his mom came to this exhibit and spent about 15 minutes playing with it. The mom pulled up a stool a bit at a distance and let her son explore. He started with the train, pushing the train car back and forth. Then he noticed the handles on the tops of the weights. He picked up the weight from the train, then the weight from the dirt car and held them and looked at them. He then put the weights back on the cars and pushed first the train, and then the dirt car. Then he moved to the boat and pushed it back and forth. He added a weight to the boat and attempted to push it, then moved the weight back to the train. Then he came back to between the dirt and train sections. He pushed them both on their own again, then picked up the train car and put it in with the dirt car and pushed them both on the dirt. Then he picked the cars up and put them both on the train track and pushed them both on the track. Then he got the boat and put it on the track with the other two and pushed on all three. He moved the boat back to the water and tried to put the train car in the water; his mom intervened and told him those cars needed to be kept dry. At one point when the two cars were on the train track, the mom said: "Look, it's bumpy. Bump, bump, bump." He repeated all of these activities at least twice and sometimes three times. When an older boy approached the dirt car at one point, he raced over and put his hand on the weight and the boy moved on. The boy continued to experiment until his mom said: "Let's go look at a new one" and they moved on.

Feedback On Individual Components

In this section we focus on issues at components that could possibly be revised; in general the exhibits all worked fairly well in terms of navigation, with exceptions noted below.

Give It a Lift

- People were having a kinetic experience of mechanical advantage, and were using the label terminology to describe it. Visitors could see that there are things that make it easier to lift heavy weights. This is experiential but not conceptual – that is, we did not see many people reading the labels and understanding, intellectually, why the various forms of mechanical advantage work the way they do. People do use the sample weight. At the Hydraulics sub-components, three to four groups made the connection to their car jacks.

Notes about individual sub-components

- Hydraulic jack: Needs a better non-leaking jack. The close/open valve is confusing. If lever is up they try to pump it, but they aren't successful. There are too many opportunities for visitors to get negative feedback, so they get frustrated and leave. The valve looks like a pump. Only two people actually tried to figure out how hydraulics work.
- Pulleys: We would like to see the blue pulley length visibly longer, since that is the concept; in its current setup the blue rope is very similar to the length of the red rope.
- Pneumatics: We recommend that staff try a bellows setup if it's possible to install a more robust valve. Visitors want to push (not squeeze). Visitors think they have to twist, rather than push, the release mechanism.
- Lever: We didn't see anyone try the lever challenge suggested in the signage, and we see this as a missed opportunity to have a more in-depth experience of mechanical advantage. Staff could try moving the "challenge" text down to where visitors' attention is (i.e., on the table-top). Staff also brainstormed placing grips along the length of the lever to encourage visitors to push at different places.

Waterways

- This exhibit is one place where we recommend staff spend time prototyping instructions – visitors need help understanding how the exhibit works and how to navigate it (as in, "step one, put the boat here."). People approach this and want to work through it step by step, but the label in its current status gets in the way of people understanding what's going on. If there isn't enough water above the gates, they don't stay closed, which adds to the confusion about what's going on. Also,

visitors can't see the water moving through the tubes, which look either completely full or completely empty.

Feel the Friction

- Boat: When the weight is on the boat it sinks, which actually makes it harder (not easier, as indicated by the signage) to move things from here to there. Also, in its current design, the boat is often used as a wave machine, which creates a big mess!
- Train: The wheels on the train need to be continually lubricated to make the point of the exhibit clear; this should be described in the maintenance manual for this exhibit.
- Weights: Visitors may want to experiment with different weights. This is a variable rather than necessary to do the exhibit. We recommend including a "weight rack" so that people can use the exhibit with and without weights.

Start Your Engines

- A staff member suggested having signs say, "watch these parts" (rather than "find these parts") which would emphasize attention to the ways the engines are different in their behavior. In our debrief with staff, we discussed changing the layout of each component so that engine models are oriented 90 degrees to each other.

Rocket Force

- This exhibit is mostly about pumping and launching, which is particularly satisfying for little boys – and the pumping serves a purpose which is a plus for the current design. We discussed with staff the fact that adding an air pressure gauge would likely augment scientific understanding about what's going on.

Earthmovers

- Changing the number of balls helped (see above). The signs are probably too complicated, given that this exhibit is most attractive to very young visitors. We didn't see adults reading more than the first- and second-level information. The graphics seem to augment the experience; we saw people pointing to them and talking about the activity.
- We observed lots of different arrangements of the simple machines, and people using the vocabulary of the various machines. This exhibit is very attractive to young visitors, and they are, because of the nature of the exhibit, "moving things from here to there."
- We saw a few cases of kids throwing the balls very hard; we recommend that staff make a note in the exhibition guide for floor staff in renting museums to keep an eye on this.

Set Sail

- The sign is too high to read.
- This is fun for groups; saw lots of experimenting particularly with wind direction and origination, and some with changing keels and sails.
- Families used this exhibit a lot. It is particularly popular with toddler- to 5 year-olds, with their parents. We saw visitors spend quite a bit of time here, and they make up their own challenges.
- The aerodynamics in the exhibit are very subtle; this feels like somewhat of a missed opportunity to provide more opportunities to investigate.
- If it's relatively easy to change, we suggest designers try experimenting with two spring-loaded air supply hoses, and two that are movable.

Up, Up and Away

- People like this exhibit a lot, they know what it is, that it will float. We heard comments like, "Look... there it goes! Isn't that cool!" People were very patient with it, and in general read signs as balloon was filling.
- Signs added at base of balloon helped some – people see and read them.
- There is confusion about what the button does. If people come up when it's half way through it's cycle and you push the button and nothing happens, it's confusing. We understand staff plan to change the timer so that this doesn't happen as often.
- Staff will likely continue to refine picture graphic to eliminate confusion about air speed, height and direction as it influences the balloon behavior. Staff trying to think of a more kid-friendly word for "dense."

Hovercraft

- Placement of sign is very important here; need to take advantage of the natural cueing behavior that happens at this exhibit.
- We recommend putting the "How You Make This" information on a sheet visitors can take home.
- We still saw that most people did not see into the plexi sides so that they could view the vacuum system. Designers could make all sides of the exhibit plexi so that the workings are transparent – this is a minor priority, but one that might be good to do if there is time and money.

Wing Thing

- This exhibit still felt overly complex to us, particularly the science in the signage.

- We did see some experimenting with wind speed, changing of wings and wind speed, and pointing to shape of wing. This exhibit provides a chance to experience a phenomenon kinesthetically and visually, but it is very difficult for visitors to articulate science concepts and explanations.
- Changing the wings is awkward; wings in storage bin cover table-top label. Could the wings be on some kind of hook or rack?
- We noticed that this exhibit tended to get overlooked more than others; we think this is because it was in the corner of the gallery, it was at the base of the stairs to leave, and it was very near two compelling water exhibits and the hovercraft.
- We discussed with staff the idea of having just one wing, and one experience, that people could perhaps be more successful with. There needs to be a more compelling way to see the differences in pressure on the top and bottom surfaces of the wing.

June 11, 2007

To: Directors and Staff members of The Family Museum in Bettendorf, Iowa and Discovery Center in Rockford, Illinois

From: Becky Carroll and Lynn Stelmah, Inverness Research Associates

Re: Notes from Inverness Research Associates summative site visit to “Get the Message” at The Family Museum in Bettendorf, Iowa on June 7&8, 2007

We begin by acknowledging the presence of the museum directors, and exhibit and program staff members from both museums at this site visit. We appreciate the time they took to attend and share their progress with “Get the Message” and thoughts about the TEAMS project overall. We also appreciate their efforts to drive attendance on the days we were visiting with a free admission day on Thursday and a school group of 85 first-graders on Friday.

We observed (approximate numbers):

Adults: 70 (20 males/45 females)

Teens; 14 (5 males/9 females)

Female children: 3 and under – 6; four to five year olds – 8; six to seven year olds – 23; eight to ten year olds – 9; 10 to 12 year olds – 6.

Male children: 3 and under – 5; four to five year olds – 7; six to seven year olds – 23; eight to ten year olds – 10; 10 to 12 year olds – 1.

Overall observations and feedback about the exhibition

- The exhibition is attractive to visitors. The exhibition color scheme is pleasing and the cabinetry at a height that is not overwhelming to small children.
- In exit interviews, when asked, “what would you tell a friend or neighbor this exhibition was about?” this is what we heard:
 - “Talking, communication” – a female teenager
 - “Things around you in every day life – construction, newspapers” – adult female
 - “How to communicate” – adult female
 - “Fun” – 6-year old female and a female teenager
 - “Working somewhere” – 6-year old female
 - “Ways to send messages, how to express” – adult female
- Visitors of all ages and genders find something to do in this exhibition.
- Adult and child visitors interviewed said the exhibition was “fun.” Staff members of The Family Museum and Discovery Center said that visitors having fun is important to them. In an interview with grandparents of a 4 year old girl, they said this exhibition was

one of the best because of the “hands-on” and their granddaughter was “having fun.” They come to the Museum once a week from Peoria.

- The exhibition has three very noisy exhibits (What’s that Sound? Stop, Look, and Listen; Construction Instruction), and some exhibits that create either a more calm visitor response (Sentences Have Patterns, Ancient Graffiti, Create a Crest) or require visitors to talk to one another (Instant Messaging, Partners). The exhibits of a quieter nature, especially those that require visitors to talk to one another should be grouped away from the noisier ones.
- We have some durability concerns, primarily around the crane. The “packages” get used very aggressively and frequently and were already showing a lot of wear and the exhibit had not been on the floor very long. Staff brainstormed about possibly using a pile of pool noodles looped together that would look like pipe and that might not encourage visitors to swing on them as much as the package seems to. The rubbing station at Create a Crest also had a lot of crayon on it. We also wondered about the 8 computer components and how durable those would be over time.
- In addition to the title, we encouraged museum staff to come up with a one-liner for almost all the exhibits that could be placed prominently that tied the exhibit closely back to the larger theme of communication. For example, at Ancient Graffiti, they could place a sign that says, “Draw your own cave art” or “tell your story through pictures” above the two computer screens. We thought there was an opportunity to get people having more conversations around communication rather than just the procedural aspects of the exhibits.
- The exhibit designers may want to consider the addition of photos showing real life applications at some of the exhibits like Create a Crest, Instant Messaging, and Construction Instruction to help visitors know what to do and add visual interest and context.
- The Totem Pole and Satellite exhibits were not part of the exhibition when we viewed it.

Accessibility

Activity tables and the Crane cab have been constructed so that wheelchairs can roll near the exhibits. The stools at the exhibits may prevent wheelchairs from rolling completely up to the exhibit though. As the exhibition is configured at The Family Museum, there is room amongst exhibits for wheelchairs to maneuver.

There are two places where we saw even sighted visitors tripping or bumping their heads: the TV news wall angled out into the pathway, the low box at Construction Instruction, and a metal bar on the entrance to the Crane cab. These could be hazards for blind and low vision visitors.

The black type on white or lighter background on the labels is great for all readers, but especially helpful for low-vision readers. And it looks like the label font size is at least 18-point which is the minimum.

Hearing impaired visitors can probably access most of the twelve exhibits, the exceptions being What's that Sound? Partners, and the Leno video that is not close-captioned.

Family Learning

"Get the Message" fosters a lot of visitor physical activity — drawing, coloring, moving things, role-playing, and pushing touch screens. Three of the twelve exhibits: Instant Messaging, Construction Instruction, and Partners require interaction between two or more visitors. There are plenty of stools and chairs to allow for pairs or groups of visitors to sit and work together.

Some of the exhibits are about participating in different kinds of communication: using Morse code, reading the news, giving hand signals to a crane driver, drawing, and choosing symbols. Some of the exhibits are about identifying sounds and signs of communication. One third of the exhibits (4 out of 12) are about "getting it right": Instant Messaging; What's that Sound? Stop, Look, and Listen; and Partners.

Most families appeared to be enjoying their time in the exhibition. There are opportunities for adults to congratulate their children for getting something right and for adults to guide children through an activity by issuing instructions.

The exhibition does not encourage visitors to explore phenomena, experiment, or participate in the scientific process. In the debriefing session, we talked about ways to promote experimenting and to encourage richer conversations by changing label copy. These changes are referenced in the notes about the individual exhibits.

Vignette at Sentence Structure: A mom with a three-year-old girl use the exhibit. Mom holds the girl in her lap. The girl starts stacking the blocks and the mom organizes all the blocks in the bin by color. As mom reads the label, the girl starts setting blocks out randomly. A six-year-old boy joins them at the exhibit. Mom says to him: "It's sentence structure. Make a sentence." The boy leaves. The girl fills the top line. Two more male children join in – one eight, and one nine. Mom: "Each color represents a different language – well, no that is not right... like a verb, a noun, and adverb. Red is a noun." She explains the colors and their correspondence to the other parts of speech. Mom: "Take five word blocks – two reds, one purple, one green, one blue. Put them in that order. These words make a sentence. You can do it on the floor." The two boys grab a handful of colored blocks and sit on the floor with them, arranging them in the order mom suggested. The little girl continues to play with the blocks at the exhibit while she sits on mom's lap. Mom has to tell the boys the order of arrangement again. The boy reads her his sentence: "spiders dig young princes

well. I made a sentence!" Mom: "Good job! I would love to get these blocks. These are great!"

Conversations

"Conversations" between visitors were mostly instructional or supportive, especially at the exhibits that are about "getting it right". Here is a typical example:

Mom with eight-year old boy at the Crane exhibit: The boy steps in to use the Crane and Mom stands right behind him. Mom: "You can do this. Push the button. Swing the load. Very good. Good job! Drop it in the truck, there's a hole for it there. OK, let someone else have a turn now."

The following is an example of a conversation that went a little beyond instructional and supportive, and took place at an open-ended exhibit, Sentence Structures:

A dad with his seven-year-old girl:

Dad reads the label out loud, starting with "Try this." He tells her how many blocks of which color to choose and says, "Put them in this order: one red, one purple, one green, one red, one blue. Do these words make a sentence?" They set a sentence up and the two read it out loud together: "Markers move cool robots nicely." Dad: "Which one of these words do you want to change?" He rotates one of the blocks. The girl reads the sentences out loud from here on out with dad helping her with words she doesn't recognize. "Tools move cool robots nicely. Tools drive cool robots nicely. Cats drive cool robots nicely. Cats drive cool cows nicely." They laugh about that last one. "Cats drive mighty cows often. Cats drive mighty cows often. Ducks see open balls today. Ducks see silly balls often." Dad switches one of the red blocks. "Do you know what that word is?" The girl reads "lions." The girl clears all the blocks off and she and her dad stack them all on the top row by color. Dad: "Now let's do it again. Here, you pick the red block you want. Want to know the order you put them in again? Red, purple, green, red blue." The girl closes her eyes as she makes her pick from each batch of blocks. She reads: "Lions play good drums quickly." She switches one block. "Lions play good drums here." Dad trades out a purple one while she switches other words. Together, they make: "Dogs get strong lights here." The girl then chooses new blocks to make: "We see pretty princes here." Then she adds now to the end. "We see pretty princes here now." They put all the blocks back in the bin and leave.

Notes on Individual Exhibits

Ancient Graffiti

Observations, Interviews, and Vignettes

- This is a popular component that is mostly about drawing and doodling—kids drawing happy faces, writing their names. We saw only one drawing that mimicked the cave drawing ones on the wall—a hand.
In an interview with three middle school youth, one male and two female, they said they were “doodling.” They liked this exhibit because “you can be creative, express yourself. The two females had studied cave art in school. When asked if this is about communication, one female said, “With art, people try to express themselves. I’m not sure that’s what this exhibit is about, but sometimes artists want to express ideas.”
- Kids want to be able to erase just part of their drawing.

Questions and Suggestions:

- Ancient Graffiti could be a place where additional conversations and family interactions could be encouraged around telling a story. We suggest labels that ask visitors to: “draw a story about your life” “try drawing a cave drawing like these on the wall”
- Navigational directions are not needed – people know what to do here and the computer interface has what people need already.
- The part of the label about carbon dating did not seem terribly relevant and may not be necessary.
- The attract screen with examples of hieroglyphics and cave paintings is nice – set timing so that it gets back to it after the exhibit is not used for a minute or so.

What’s That Sound/Stop, Look and Listen

Observations, Interviews, and Vignettes

- People get that these are matching activities.
- It is mostly trial and error and guessing for people; because so much is about getting it right, the exhibit doesn’t seem to allow for conversations or hypotheses.
- Sirens are too similar.
- It seems like this is a lot of cabinet space to house a computer.

Questions and Suggestions:

- The wording/noise when visitors get it wrong is off-putting; needs a different message. Perhaps “oops try again” without noise.
- With Stop, Look and Listen, there is a miss-match between the interface – the “ca-ching” and “boing” sounds and illustrations – with the content – driving signs that kids wouldn’t know and words like “impatient motorist.” Who is this exhibit geared for?
- There are perhaps too many signs on Stop, Look, and Listen and this could be streamlined.

- What's That Sound is scary to young children. It is way too loud and we suggest placing it with other noisy things. We heard from a couple of mothers that their children were afraid of the barking dog and photo, and the tornado.
- This is an example of an exhibit that needs to be tied more strongly back to the theme of communication. An example of a suggested tag-line label: "when a message needs to be gotten across quickly and without words, symbols are used/ sounds are used".

Sentence Structure

Observations, Interviews, and Vignettes

Vignette: A mom with a three-year old girl use the exhibit. Mom holds the girl in her lap. The girl starts stacking the blocks and the mom organizes all the blocks in the bin by color. As mom reads the label, the girl starts setting blocks out randomly. A six-year old boy joins them at the exhibit. Mom says to him: "It's sentence structure. Make a sentence." The boy leaves. The girl fills the top line. Two more male children join in – one eight, and one nine. Mom: "Each color represents a different language – well, no that is not right... like a verb, a noun, and adverb. Red is a noun." She explains the colors and their correspondence to the other parts of speech. Mom: "Take five word blocks – two reds, one purple, one green, one blue. Put them in that order. These words make a sentence. You can do it on the floor." The two boys grab a handful of colored blocks and sit on the floor with them, arranging them in the order mom suggested. The little girl continues to play with the blocks at the exhibit while she sits on mom's lap. Mom has to tell the boys the order of arrangement again. The boy reads her his sentence: "spiders dig young princes well. I made a sentence!" Mom: "Good job! I would love to get these blocks. These are great!" They move on to the Kids TV News exhibit.

Questions and Suggestions:

- Could be made more open-ended. Label suggestion: "Make a sentence using these blocks".
- The navigation label could be placed on the exhibit above where people are working with the blocks; colored blocks could be used with the words noun, verb, adjective and adverb lined up in the order needed to make a sentence to give people a more immediate visual cue about what to do here.
- Sarah suggested including blocks with pictures on them for pre-readers who are attracted to the blocks.

Partners

Observations, Interviews, and Vignettes

- Current placement is in a very noisy part of the exhibition – everyone had to open the door to talk through it and to hear. We suggest moving this exhibit near quieter ones.
- Most of the conversation around this is procedural— about giving instructions. One parent said she liked this because it teaches kids to listen to directions.

- In an interview with one mother, she said that she home- schools her daughter and she hadn't gotten to grids and graphs yet and so this was a good introduction for her daughter about grids and graphs.

Kids TV News

Observations, Interviews, and Vignettes

- Many kids we spoke with and overheard said this is their favorite.
- This is about kids seeing themselves on television.
- A lot of kids read the teleprompter.
- Only communication is that it is people talking at no one in particular.
- One mother was explaining to her daughters how in real life, the television people look at the teleprompter and not at the camera and it looks like they are looking at the camera.
- The table tips.
- Tripping hazard in wall extending out from back wall.

Questions and Suggestions:

- Shorten the prompter info.
- The teleprompter "news" about Pluto is out-dated—could be removed.
- Need tagline label that ties this back to communication.
- Adjust side wall and table so they are not hazards.

Front Page News

Observations, Interviews, and Vignettes

- Visitors like this; they printed out several newspapers – liked having picture on the paper.
- Gets messy with lots of discarded newspapers.

Questions and Suggestions

- We aren't seeing any evidence of communication here... what could you do to encourage that?
- What is the point of the exhibit with regard to what you want to communicate about communication?
- What label copy could help?
- Needs a recycling bucket.

Sign Language

Observations, Interviews, and Vignettes

- Parents especially like this one. We saw kids and parents watching it and trying out the signs.

Questions and Suggestions

- What's missing is the context of a meaningful activity that would make it more than a dictionary. Add a challenge: "See if you can say a sentence to the person you are with in sign language" or "Use sign language to greet the person you are with."

- Tie exhibit into communication theme in label or tag-line label.

Changing Faces

Observations, Interviews, and Vignettes

- Visitors just spin the faces.
- There is nothing that tells you what to observe here – why spin those?
- The label that tells you what the various facial expressions might mean is placed far from the spinning faces.
- Saw one child look in the mirror, but not in conjunction with spinning the faces.

Questions and Suggestions

- Label copy: Ask visitors to “Make a face that communicates being mad, being happy, confused” so there is a greater connection between the faces and emotions being conveyed.
- Place labels right next to spinners.

Crane

Observations, Interviews, and Vignettes

- Hugely popular
- This exhibit is mostly about operating a crane.
- The big sign is often not seen by people – kids stand in front of it. However, near the end of the visit, the addition of the foot pads with the sign that said Stand Here And Signal the Crane Operator was used by visitors, and we saw more visitors using the hand signals on the big sign to direct the crane operator. The addition of this sign helped immensely in cuing visitors as to what to do.
- Parents catch on to do hand signals.
- Saw kids jump out of cab and run out front and check things.
- Unsafe behavior here – kids climbing on the cab of the truck; kids swinging off the pads; pads dragging through little kids; no injuries or knock down.
- Interview with 11-year old doing it by himself: “It’s about moving things. You are supposed to have two people, but I have done it three times already so I know how to do it.”
- Vignette: A mom with two seven-year old girls use this exhibit. The girls start using it on their own at first while mom finishes looking at another exhibit. One girl enters the cab and calls her friend over. “Where is it? (looking for the load). One girl runs around the front, finds it, and then comes back. “It is right over there!” Both inside the cab, they work together to raise the load. “Watch out!” They laugh. Mom approaches, sees the labels on the front, and directs the girls to “put the load in the red box.” The first girl asks, “Where’s the red box?” Mom points to it and uses her hand to gesture the girls to move the load further to their left. Then she points down and the girls lower the load into the box. Mom scoots the box with her foot so it is a perfect fit. The second girl says, “Let’s go see!” They race around the front, take a quick look, and then run back into the cab. Mom makes the lift gesture with her hand, and the girls raise the load. Mom gestures to them to move the load to their right, toward the truck. As the load moves, Mom moves with it. The girls tell her to move to the side. At the truck,

Mom gestures to the girls to lower the load, then makes the “stop” gesture when it is down. As they lower the load into the truck, one girl says, “going down into the blue truck! Let’s go see!” Once again, they run around to check out how they have done. Then it is back to the cab to raise the load again. Mom points to their left again and one of the girl runs out to join mom in the signaling department. As the mom and girl give directions through hand signals, the other girl moves the load and lowers it into the red box. Then it is back to the truck, with the mom and girl giving hand signals. After they get it into the back of the truck, the one girl raises the load and puts it down on top of the cab of the truck. They all laugh. The girl raises the load, the mom signals stop and points to the right. The girl lowers it into the back of the truck again and they all leave to let other kids have their turn.

Questions and Suggestions

- Need a sign inside the cab that directs visitors in there to get someone out front to signal the crane operator; perhaps a real-life photo or illustration.
- Staff members are thinking of ways to change the bundle of foam cushions that is “the load” to something that kids won’t drag, sit, or lay on. Someone had the idea of using the foam tubes used for floating in swimming pools.

Instant Messaging

Observations, Interviews, and Vignettes

- Having a video on the backside of an exhibit where two people need to talk together and work together does not work for visitors.
- We did not see anyone look at the Leno video for more than two seconds.
- Lots of navigational time spent in trying to come to a consensus around what constitutes a dash and a dot; the addition of the short signs right above the transmitters was noticed and used by visitors and seemed to help.
- We observed inter-generational interactions between two sets of grandparents and grandkids.
- Visitors, especially adults with children, are intent on doing it.
- School group children without an adult just pushed the coder and did not seem to know what to do, nor did they read the signs.
- Interview with 11-year old boy: “This is fun, cool. I’ve heard about Morse code, but never tried it.”

Questions and Suggestions

- Add a photo of two people sending Morse code to each other so visitors get the idea it takes two people to do this.
- A teacher suggested using the words “short” and “long” to describe “dot” and “dash”.
- Add label to Leno video to give it context: “Who is going to win – text messaging or Morse code?”

Create a Crest

Observations, Interviews, and Vignettes

- Kids like the rubbing activity.
- Kids can't find the paper.
- A lot of paper on the floor from this.
- We saw very little conversation or family learning though we think there is potential for that here. We think perhaps adding a label that encourages visitors to work together to create a coat of arms about their family or school group might encourage further conversation here.

Questions and Suggestions

- Suggest title label copy that encourages visitors to engage in an activity that is more tied to what a coat of arms means. Example: "Color a coat of arms that tells something about you, your family, school, or some group you belong to."
- Add photos of coats of arms, logos, etc.
- Put label near paper bin so that parents can see it.
- Need a recycling bucket here.

September 5, 2007

TO: Museum directors and staff members of Catawba Science Center and The Health Adventure

FROM: Becky Carroll and Lynn Stelmah, Inverness Research Associates

RE: *Spin: The Science of Rotation* Summative site visit on August 10 & 11, 2007 at The Health Adventure, Asheville, North Carolina

CC: TEAMS directors, Dawn Huntwork, Jenifer Helms, Mark St. John

This memo is a summary of findings about the *Spin* exhibition reviewed by Becky Carroll and Lynn Stelmah in August 2007 at The Health Adventure in Asheville, North Carolina. The purpose of this summative site visit was to see how well the thirteen final-stage exhibits worked with visitors in terms of accessibility, family learning, and conversations. It was also to interview The Health Adventure Museum Director and staff members from both museums to hear their thoughts on the *Spin* exhibition and the TEAMS collaborative overall.

We begin by acknowledging the presence of The Health Adventure museum director and educational staff, and exhibit staff from both museums at this site visit. We appreciate the time they took to attend and share their thoughts about *Spin: The Science of Rotation* and about the TEAMS project overall. We also want to recognize the progress staff members have made over the course of the TEAMS I–III projects. Museum director and staff members told us that their professional development was considerable, having learned a great deal about developing exhibits, especially with regards to accessibility, family learning, and prototyping. They also said that being part of a larger collaborative was not only useful for the advice they received from colleagues, but also morale boosting by their participation in a national project funded by the National Science Foundation. These interviews were audio taped for Inverness to reference for the final report.

Becky interviewed The Health Adventure education staff members and reviewed the *Spin* program guide they had developed; these materials were thorough in their coverage of science concepts related to the exhibits, well-laid out and very user-friendly; and should be a good resource for education staff at other museums.

The Overall Exhibition

Becky and Lynn observed/interviewed 74 groups overall involving 63 adults (22 males and 41 females), and 99 children (35 male children and 64 female children): mostly family groups of at least one adult with children. Children ranged in age from 3 to 14.

Context and Caveats of Site Visit: The *Spin* exhibits were set up in and among other Health Adventure exhibits including exhibits on health, food, magnets, and a video on a chain reaction (which we asked to be turned off on the second day of the site visit because visitors were using the *Spin Speed* chair to sit in to watch the video). Because of the layout of the exhibition, it was difficult for visitors to grasp the overall theme of *Spin: The Science of Rotation*. After initial attempts were unsuccessful, we did not ask visitors questions relating to the overall messages of the exhibition.

Three of the *Spin* exhibits were not available for us to evaluate due to fabrication issues at the outside fabrication contractor's shop. These exhibits were *Feedback* (formerly *The Governor*); *You Spin*, a graphic that evaluators have never seen as a prototype; and *Dynamic Dot* (formerly the *Rotating Laser*). There was an additional exhibit, *Coriolis Effect*, purchased from the Exploratorium that evaluators had not seen before in the context of *Spin*.

In addition, some of the exhibits did not work to their full capacity. *Pit Stop* (formerly *Racing Cars*) was missing its second car until mid-afternoon of day two of the site visit; *Let it Roll* (formerly *Rings and Discs*) and *Racing Rollers* also had fabrication glitches: one of the ramps in *Let it Roll* caused the discs to wobble which interfered with the results; the cones on *Racing Rollers* fell apart a few times during the site visit. Jesse said the fabricator did not follow his specifications.

In retrospect, in order to conduct a thorough summative site visit, it would have been better for evaluators to view *Spin* once all exhibits were fabricated and working the way exhibit developers had specified them to be built. With this in mind, we will report what we did ascertain about accessibility, family learning, and conversations during this site visit and make recommendations for those things that we think can and should be changed.

Invitation: The *Spin* exhibits are engaging, colorful, attractive, and inviting. We observed visitors enjoying them. There is appeal for females and males and all ages: children, parents, and grandparents. There is a good balance of open-ended and concept-teaching exhibits. In addition, several of the exhibit components (*Let it Roll*, *Pit Stop*, *Spin Speed* and *Racing Rollers*, in particular) were used for long periods of time by visitors. Exhibit staff said that having long hold-times at exhibits was a goal for this exhibition, a goal they clearly met.

Main Ideas: We encourage staff members to articulate the *Spin*'s main messages in relation to the connection between spin to weight distribution, size, forward speed, and spinning speed. We encourage staff to utilize signage copy, including introducing these concepts in the introductory panel, as well as the grouping of exhibits, to help convey main messages and reinforce key concepts throughout the exhibition. In particular, the grouping of exhibits with like concepts seems key to providing visitors opportunities to make connections and build on science concepts (we provide vignettes that illustrate the potential of visitors making these connections between exhibits in the individual

exhibit notes below). We hope your schematics accompanying the traveling exhibition will indicate to the other museums what exhibits should be grouped together.

Labels: In all of our site visits we saw several parents and grandparents reading the signage. Many adults seem to want to be able to convey to their children what is happening or encourage them to experiment. We suggest signage that tells or shows visitors how to navigate the exhibit when it is not intuitive, and asks questions that encourage visitors to do activities and make observations. *Weighted Wheels* is a good example of signage copy that works (we will say more about this in the notes about this exhibit in the individual exhibits section).

In addition, labels need a careful review to ensure that the activity involved connects to the concepts articulated in the signage. An example of where this does not work is *Pit Stop*. The signage refers to how size affects both forward speed and power, but visitors can only experiment with the concept of size affecting speed, not how size affects power.

Staff told us in the debriefing that they plan to bring in real-world examples and applications through the use of LCD panels. We think the addition of real-world examples is a good idea and encourage the use of these images in both the introductory panel and individual exhibits.

Accessibility: We did not observe any visitors with mobility or vision or hearing disabilities so it was not possible to determine how accessible the exhibition is. Staff members said they have a good understanding of heights and spaces that should work, and a quick review by Lynn of tabletop heights indicates that this appears to be the case. We hope the schematics for the traveling exhibition will indicate space between exhibits for wheel chairs to travel. The current signage appears to use a minimum 18pt size and we assume the final signage will too.

Family Learning and Conversations: examples of these are included in the following section on exhibit components:

Individual Exhibit Components

Laser Show

The use of this exhibit as a component in the introductory panel is creative and economical as its movement and color attract attention. We saw visitors going back and forth looking at both views: the front/introductory panel and the side where visitors spin the mirrors.

The signage mentions “persistence of vision” as one of the concepts behind how the laser works. It is hard to get this concept without being able to see the laser as a single point. We are not sure this needs to be included in this exhibit and if exhibit developers

decide to keep it, we suggest that this concept be explained in a “going deeper” part of the signage.

Is it possible to use non-glare plexi-glass on the panel where the dials are? The glare from overhead lights interferes with the exhibit.

Vignette of a 7-year old boy who said to Lynn, “I made a star” and then explained how he did it and how the speed of the spinning mirrors made different shapes. He also pointed to the signage and said, “It tells you here,” and read the sign out loud. He told Lynn he knew the word “phenomena” because he heard it in school, but he did not know what ‘persistence of vision’ meant.

Vignette overheard by Becky of a mom using this as a tool to teach about shapes and to teach words: A mom with a 12 year old girl and twin daughters, age two, approached the exhibit. The older girl began using it, but was quickly moved off the exhibit by one of the twins (the other girl was sleeping in the stroller). Mom said: “Oh, laser show. You have to turn the dials to make different shapes. You remember what shapes are, don’t you? Rectangles, circles, triangles, squares.” The little girl started twirling the dials, and was very excited. “Look at it!” “Look at it!” Mom then asked her, “What shape is that?” The girl said, “Circle!” She then said, “Circles! Eights!” “Look at it!” Mom said: “Yes, it makes different shapes when you turn it. That’s a laser. Can you say ‘laser’?” The little girl said, “Laser!”

Pit Stop (formerly *Car Wheels*)

Visitors were attracted to this exhibit and knew intuitively to change the wheels from small to big on the cars.

The powering mechanism was difficult for visitors to attach the cars to and therefore the car(s) did not always illustrate the concept of how wheel size affects speed. Visitors walked away often when it did not work.

There is no way for visitors to experiment with how wheel size affects power which is mentioned in the signage. This is confusing to visitors as exemplified in the following vignette:

One seven-year old girl called her mom over to this exhibit. “Mommy, look at this. You have to place this car here.” Mom launches the car, and then apologizes to the girl. The girl re-sets the car and launches it. Her grandma walks up and tells her, “You have to change the wheels.” The girl then set off on a very methodical exploration of the different sized wheels. She started with the smallest: “Let’s start with the littlest size,” she told her mom and grandma who were standing off to the side letting her run the show. She launched the littlest, then took the wheels off the car and placed them on the other track at the spot where the car stopped. She did the same thing for the middle-sized wheels and then the largest wheels. “The slow pile is right here, the fastest is right here.” Her mom occasionally weighed in about the results: “Those wheels seemed

better than the last ones.” After she did all of her experiment, her mom asked, “So what does that tell you?” The girl said: “That the bigger it is, the faster it is.” The mom then asked the girl to read the sign out loud, which she did. Later on in her visit to the museum, she brought her dad back to this exhibit and told him what she did, saying: “You know why the big wheels go faster? Because they have more power.”

Exhibit developers say they plan to include graphics that illustrate real-world examples of concepts. We wonder if they do this, if the illustration and copy about power should be in the “going deeper” part of the sign.

Fast Lane (formerly *Wheel Speed*)

Many visitors approaching this exhibit did not know what to do here. The push button to start is away from the activity and several visitors had trouble locating it to get the track spinning.

In addition, several visitors could not figure out how to move the car back and forth on the rotating track and didn’t realize they needed to move the sliding arm, not the car itself. We observed several visitors tugging on the speed gauge. Because sliding the car itself is intuitive for most visitors, we suggest finding a way to make a car big and sturdy enough to be moved back and forth.

The wheels that are spinning are not those of the car, so it is not the car that is changing speed but the wheels mounted underneath. If visitors do figure out how to move the car mechanism, they seem to get the basic idea of the exhibit.

Racing Rollers (formerly *Speeding Cones*)

This is a compelling exhibit, one that visitors are attracted to and intrigued by and one that visitors spend time at.

The rotating tracks of the prototypes in which children’s fingers were sometimes caught have been exchanged for individual wooden pieces with different widths of tracks. However, these tracks are heavy and smaller visitors have a hard time moving and arranging them along the channels.

To help visitors see that the width of the track affects the rollers’ forward speed and spinning speed, we suggest highlighting with color the different widths of the tracks to draw attention to this. Exhibit staff plan to do this; the fabricator did not get this completed prior to our site visit.

The exhibit’s signage could also include guiding questions that direct visitors to observe the interaction of the roller with the different tracks. One possibility to help visitors notice this would be eliminating the medium width tracks and the medium-size part of the roller as the difference between those and the narrower and wider tracks and roller parts is too subtle and difficult for visitors to see.

It is still difficult for visitors to see the rollers spinning faster. Perhaps a question in the signage like “Do you notice any difference in the roller’s spinning speed?” could direct visitors’ attention to this.

Several visitors thought that the two rollers were different from each other somehow and the exhibit was about comparing the differences between the two rollers. One ten-year-old girl told Becky: “The sign says the rollers are made of different wheels, so these are different.” Staff changed the language on the sign during day two, but we didn’t have much opportunity to test it.

Vignette: A 6-year old boy with his grandmother. She read the sign to him. He was able to move the tracks with her help. She pointed out where the track changed and asked him, “Where would you put the tracks to make it go further?” “Did you notice something?” The boy pointed to a narrow track and found another one like it and put the two together. The grandmother asked, “Is there a way to make it go faster? He said, “Put another narrow one.” He rolled the rollers and said, “I told you it would make a difference!” “What makes it go faster?” asked the grandmother. He pointed to the tracks and asked, “The rails?” “Yes,” said the grandmother.

Vignette: A ten-year old girl used this exhibit with her mom. “I want to make it the same kind of track on both sides but I don’t have enough track to do that.” She set up three and three of different tracks and asked her mom to help her launch one of the wheels. They switched rollers and run them down the other tracks and get the same results as before. Mom asked: “They seemed to go at the same speeds. What did we learn about the tracks?” The girl said: “The smaller wheel goes slower but has more power – we learned that at that exhibit there (points to *Pit Stop*), so maybe why it can go farther up the side here.” She looked at the track and the rollers again. “I thought these wheels were different but they aren’t.”

Vignette of a parent-child conversation/interaction at exhibit: A four-year old girl and her six-year old sister used this exhibit with their dad. The four year old began using this by herself at first, rolling one of the rollers up the track, pushing it up as high as she could and letting go (she could get it not quite all the way to the top – that didn’t seem to bother her). She did this again as her dad approached and said, “Watch your fingers!” She rolled both wheels up and let them go. Dad said, “Why do you think that it goes so much slower on this part?” The girl said, “Because I am doing this!” and showed him how hard she is pushing off on one of the rollers. The dad said, “Try doing that on this side and see if it does the same thing.” The six-year old joined them at this point, asking, “Want to do them at the same time to see which one goes the farthest?” The dad read the label to himself while the girls launched the rollers. Dad said, “Look at which wheel is touching the track there. You can move the track pieces.” He changed one piece of track around, saying, “Let’s see what happens.” They launched the rollers, and then rearranged the tracks again. They launched the rollers again, and this time, noticed the difference between the fast and slowest tracks. Dad said, “That was neat!” The four-year old girl said, “I love this game!” The girls started rolling the rollers,

pushing them as fast as they can with their hands while they roll. “Vooma kabooma!” the four-year old said. Dad said, “We should build one. Have you figured out what makes it go fast and slow?” The six-year old said, “The two parts have to be together.” They leave for the *Air Thrusters* exhibit after using this for over five minutes.

One adult male said: “Faster on the way down means it goes farther up. It’s momentum!”

Human Centrifuge

Inverness researchers never saw this version of this exhibit in prototype form.

There appear to be no safety issues. If someone is on the platform, the tub does not move. Jesse is trying to weigh the benefits of allowing the tub to spin faster if only one or two kids are in it; right now, one or two children do not have the strength to move it very fast, which is disappointing. There was also discussion about removing the emergency stop button from the center of the turning wheel as children are hitting it all the time and it seemed fairly easy to stop the exhibit by grabbing the center wheel. We caution staff to experiment with allowing the tub to spin faster with the emergency stop still part of the exhibit before deciding to remove the emergency stop.

Kids and adults are having fun here. We didn’t see a lot of adults getting in the exhibit and spinning and think it could be due to a number of things: when adults spin, they come out much dizzier; some adults may think it is only for children; some adults may think it is embarrassing to get into the exhibit because it is small.

If the *Human Centrifuge* is placed in a more open area, where parents can stand around the whole thing, there is the opportunity to help parents participate more in the exhibit by placing additional signage around the cage.

Vignette of a parent using the sign: Father and 7-year old walked up to the exhibit, the dad read the whole sign to son; they got on. When they came off, Lynn asked the dad if the sign made sense. “Oh, yeah. But I am sure my seven year old didn’t get it, at all.” The man took his son back over to the sign and used an example of swinging something and letting it go, asking, “Would it go in a curve or go straight?” The boy said it would go in a straight line.

Connecting to other experiences vignette: Father with two daughters, ages 6 and 9 said, “This is like the ride you went on yesterday where you go spinning out.”

Fluid Centrifuge (formerly *Field Spinner*)

We did not see this exhibit being used by very many visitors, and when it was, what we observed here were kids turning the crank as fast as they could. We suggest moving it closer to the *Human Centrifuge* to see if visitors make the connection.

Let it Roll (formerly *Rings and Discs*)

As with the prototypes, we observed lots of experimenting, and parents questioning children as to what is happening. This exhibit provokes inquiry and visitors spend considerable time with this exhibit.

The signage here talks about “mass” in relation to rotational inertia, while other signs refer to “weight.” The signs should be consistent.

One of the tracks was uneven causing the rings and discs rolling in it to wobble, thus affecting the outcome. Staff members are aware of it and brainstormed solutions (for example, cover the ramps in one long strip of rubber) to address both this and the ramp wear.

There is a persistent misconception here that the solid 66 kg black disc is heavier and that’s why it goes faster: “This one weights more so it is going to go farther or faster!” Visitors don’t notice 66kg written inside the silver ring.

Vignette: A seven-year-old boy rolled one of the silver rings down the ramp. He saw the handle. “What’s this for?” His mom approached and showed him how the handle lets the wheels go. He set up the black solid one and silver ring for a race. The mom said, “Ready, set, go! Who will win? The black one! Yeah!” The boy rushed over and knocked the black one over so his silver one won. Mom said, “No fair! That’s cheating!” They set up another race. Mom said, “Do you know why it is faster (pointing to the black one)?” Because it weighs more.” The boy said, “Then the black one is mine!” The boy left and the mom rolled them one more time before leaving the exhibit.

Vignette: Two girls, ages four and six, (the same girls from the *Racing Rollers* vignette), with their mom and dad. The girls mostly used this by themselves. The six-year old put both black discs on one side and the four-year old put two of the silver rings on the other side. The discs and rings crashed into each other. “Crash caboomie!” They argued over who got to release the handle; mom helped them to take turns. They set up the same activity and repeated it again and again – letting two things go on each side and watching them crash. “I’m going to get mine to go crash caboomie too!” On one of the turns, the metal rings stayed upright and didn’t fall over. The four year old says, “Yeah!” Dad joined them and read the label. He said, “Rotational inertia” out loud. Then he told the girls, “I think you are supposed to race them.” The girls kept doing what they had been doing. Mom said, “Which one goes faster? The heavier one or the lighter one?” The girls said, “Heavier!” Dad said, “I don’t think so. It’s where the mass is placed.” The six-year old girl left the exhibit after using it for over nine minutes. The four-year old said, “I get both!” That brought the six-year-old back, and they used the exhibit for more than ten minutes.

Build a Top (formerly Table of Spinning Objects)

Because of durability issues, staff members eliminated the various kind of spinning objects and instead fabricated a table with different sized plastic discs with holes in the center, a metal rod that goes through the discs, and a “spinner” that attaches to the rods and gets the tops spinning.

Safety issue: A woman using the “spinner” had the skin peeled off her thumb. The spinner is awkward for small children to use. One mother suggested the crank area be wider or if the spinner could be used horizontally rather than vertically like an eggbeater.

We observed children and adults who didn’t understand what the top of the top and bottom of the top on the rod was. A suggestion is to include a better graphic that clearly shows which is which on the label.

We observed a lot of experimentation here, though we are not sure that visitors can make sense of the results they get. In our observations and conversations with visitors, we were unsure if visitors can see much difference between their different top designs.

This exhibit seems to be attractive to adults: we observed adults using this exhibit on their own and with children.

Vignette of boy who spent a lot of time here interacting with Jesse and Becky, trying different models of tops and seeing how long and how well they spin: We timed one of his tops with Becky’s stopwatch and the boy really liked that, so staff are considering putting a stopwatch in the exhibit.

Staff members intentionally want this to be open-ended with little signage. We do suggest repeating concept words here that are in other exhibits; perhaps just adding the question: “How does the weight and the size of discs affect the spinning of the top?”

Spin Speed (formerly *Recumbent Angular Momentum Chair*)

This is a popular exhibit – visitors mention it when they are in other parts of the exhibition.

There are still safety issues here. Toddlers and small children walk in the area when visitors are spinning fast in the chair and flinging their legs and arms out. Because of visitor dizziness, a sign should suggest visitors stay seated for a bit before they get up.

The prototype explanatory signage was not here. Staff included a rather extensive surround to help with safety issues; there is an opportunity to use the existing surround in a more instructive way by putting signage on it—especially signage of real-world applications like a figure skater.

Visitors of all ages get the idea of arms out—you go fast, arms in—you go slower. However, there is still a misconception as to “why” this happens. We heard, “The reason I go slower when my arms are out is because the wind is pushing against my arms.” Make sure the signage refers to weight/mass distribution and that this exhibit is placed near the other exhibits that illustrate this concept.

Weighted Wheels (formerly *Heavy Wheels*)

The exhibit is attractive—visitors spin the wheels. The signage here is simple and clear: it tells visitors what to do, asks them to make observations, and provokes and answers the question “why?” Staff members may want to add an additional challenge: “Which wheel spins for the longest time?”

Mediated interview that indicates the potential value of placing *Weighted Wheels* and *Spin Speed* near each other:

A grandfather watched as his nine-year old granddaughter spun in the *Spin Speed* chair and read out loud the sign that instructed visitors to bring their arms and legs in and out. When the granddaughter got off the chair, Lynn asked her, “Why do you think you went slower when your arms and legs were out?” The response, “Because my arms blocked the wind.” The grandfather and granddaughter then walked over to *Weighted Wheels* and spun them. Lynn asked her which wheel was easier to spin. She pointed to the wheel with the weights in the middle. Lynn: “Is there was any difference between the wheels?” “More and smaller weights on this one, bigger weights on this one.” Lynn: “Is there anything else that is different?” Granddaughter: “Where they are!” Lynn: “Do you think this is similar to the chair you were spinning in?” Granddaughter: “This wheel (pointing to the one with weights along the outside) is like when my arms were out.” The grandfather explained, “The weights on the outside are trying to spin off; the weights in the center aren’t.”

Air Thrusters (formerly *Air Sprinkler*)

This exhibit has been fabricated so that it is a rod with bendable arms made of colorful plastic components. The arms can be bent in many contortions. Air is forced through the arms when visitors press a button. Because of its colorful and weird looking nature, the exhibit is attractive.

We observed adult and children watching the digital photo frame to see what to do. They figure out quickly how to make it spin faster. Visitors did not spend a lot of time here; they typically bent the arms in various contortions, pressed the button, watched it spin (or not) and left. One young boy held the arm with the blowing air up to his face.

Conversations were most often parents saying to children: “Try this,” “What happens?” “Good job.”

We suggest *Air Thruster* not be placed near *Weighted Wheels* or *Spin Speed* as its concept differs from those and may be confusing: *Air Thruster* does not go faster when its arms are close to the center, the opposite happens because of the forced air.

The signage is dense and complicated and mentions “torque” in bold lettering. If the concept of torque is important to spin, how can the signage better connect it to spin? What are some real life applications that will illustrate torque and spin, illustrations that can be added to the signage?

The inclusion of the digital photo frame with photos that show different configurations of the exhibit works well. One visitor mentioned that she liked to try to make all the sculptures shown in the photos.

One ten year old girl interviewed here explained this exhibit: “I knew that if they were pointed out straight apart, the air would be pushing them together and they wouldn’t spin.”

Coriolis Effect

This exhibit was purchased from the Exploratorium. The signage that exhibit staff prepared for this exhibit fell down behind the exhibit, leaving the Exploratorium signage during our visit. The exhibit and signage look nothing like the other exhibits in *Spin*.

The few visitors we observed using this component spent less than five seconds here and did not read the signage, and wondered what to do and what this was supposed to show. We question whether or not the inclusion of this exhibit is worth the additional hassle of water and mats for other museums. Staff said they included this because it was a real-life example of spin.

Staff members suggested during the debrief that the exhibit might work better as a program piece, and to give the other museums the option to use it for that purpose.