



Science on a Sphere

Review of the Evaluation Literature

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EXECUTIVE SUMMARY

This literature review is one component of a comprehensive evaluation plan for Science on a Sphere (SOS) at the Denver Museum of Nature & Science (DMNS). It focuses on 13 evaluation reports generated by six institutions that are members of the User's Collaborative Network of the National Oceanic and Atmospheric Administration (NOAA).¹ Although these reports vary in purpose and method, each has useful information to contribute to the DMNS SOS project.

The literature review is divided into two sections, the first of which presents themes that emerged in the reading of the 13 reports: "Logistics," "Labeling," "Making the Data Engaging," "Learning," and "Beyond the Data Sets."

Several elements are critical when considering **logistics**:

- Seating is a very important factor in visitor comfort and retention.
- People need a reason to walk around the Sphere and cues telling them how.
- People want to see the top of the Sphere.
- Poor audio is frustrating and reduces learning.
- On one hand, nearby distractions may reduce viewing time. On the other hand, placing the Sphere near foot traffic may increase participation.
- If the images on the Sphere move too quickly, people have trouble absorbing information.

Labels are helpful, but should fade out at times. They can be used to keep visitors engaged.

- Labels on the Sphere – or the railings, or the wall - are helpful. Useful labels include color-keys, labels that identify items described in the audio, and "you are here" arrows.
- Since labels may interfere with the realism of the projected image or provide too much information, people appreciate when they fade out.
- Labels with questions to consider or teasers about upcoming shows keep people engaged.

Visitors are more likely to **engage with the data** if the script is solid (when applicable), if there's a chance for them to interact, and if they see things to which they can relate.

- Scripted live presentations, which allow room for audience participation, engage visitors.
- When staff invite visitors to use computer kiosks, they explore more topics, and participate more fully with their children.
- People like being able to manipulate images on the Sphere or in their kiosk; sometimes this can be complicated.
- People like seeing things that relate to their direct experience.
- Young children tend to keep people away – and pull them away – from the Sphere. However, children stay longer when they can use interactive computer kiosks.

Continued>>>

¹ The Bishop Museum in Honolulu, the Maryland Science Center, McWane Science Center in Birmingham, AL, Nauticus National Maritime Center in Norfolk, VA, the Science Museum of Minnesota, and the Tech Museum of Innovation in San Jose, CA. See http://www.oesd.noaa.gov/network/SOS_evals/index.html for details.

The SOS exhibit is a **learning** experience for visitors; the level of learning varies. Barriers to learning have been identified.

- In general, people learn new information from seeing SOS and participating in related programs/activities.
- Prior familiarity with a topic contributes to understanding.
- Comprehension of data can be categorized into different levels: e.g. “big ideas,” “new understandings and knowledge,” and “particular facts.”
- Comprehension doesn’t necessarily lead to application of knowledge.
- Lack of cohesive storylines, insufficient explanations, confusing images and distractions can be barriers to learning.

The exhibit can be an **aesthetic and affective experience**.

- People are very interested in how the images are projected on the Sphere.
- Aesthetic, affective, and attachment responses are not unusual.

Section Two describes the evaluation reports themselves, briefly describing the purpose and methods of the evaluation and listing the major findings.

For the most part, the information provided in this review speaks for itself. In just a few cases, the data begs for additional recommendations. These are:

- On one hand, seating is a very important factor for visitor comfort and retention. On the other hand, people need a reason to walk around the Sphere and cues telling them how. Therefore, it may be advisable to create benches that are easy to perch on, and easy to get off.
- Since young children tend to keep people away – and pull them away – from the Sphere, consider offering a nearby play-area or manipulatives to keep them occupied, in addition to considering interactive computer kiosks.
- Comprehension of data has been categorized into different basic levels in some of the evaluation reports. To take future evaluation further, it may be useful to think in terms of Bloom’s Taxonomy.² Some people pick up factoids, and so demonstrate “knowledge” as defined by Bloom. Others are able to articulate cause-and-effect processes (“comprehension”), or can compare and contrast what they see (“analysis” and “synthesis”).
- Aesthetic, affective, and attachment responses are not usual, as expressed in interview comments like, “I wish I had one at home,” and “I want one for my birthday.” Consider Mini-SOS gift shop items.

² A classic taxonomy of learning objectives presented by Benjamin Bloom in 1956.

TABLE OF CONTENTS

INTRODUCTION	1
Background	1
The Literature	1
How to Use This Literature Review	1
SECTION ONE: THEMES FROM THE EVALUATION REPORTS	3
1. Logistics	4
a. Seating	4
b. Walking Around the Sphere	4
c. People Want to See the Top of the Sphere	4
d. Poor Audio	4
e. Balancing Access with Distractions	5
f. Speed of Rotation	5
2. Labeling	5
a. Generally Helpful Labels	5
b. Labels Fade Out	6
c. Labels That Engage	6
3. Making the Data Engaging	6
a. Scripted Live Presentations That Engage	6
b. The Importance of Staff Invitations	7
c. The Benefits and Complications of Visitors' Manipulating Images	7
d. The Benefits of Content That Relates to Visitors' Direct Experience	7
e. Young Children and Interactivity	8
4. Learning	8
a. Generally, People Learn From SOS	8
b. Prior Familiarity Contributes to Understanding	8
c. Different Levels of Comprehension	9
d. Application of Knowledge?	9
e. Barriers to Learning	9
5. Beyond the Data Sets	10
a. "How is it Projected?"	10
b. Aesthetics and Attachment: "It's Beautiful" and "I Want One"	10
SECTION TWO: EVALUATION REPORTS FROM THE USER'S COLLABORATIVE NETWORK	11
BISHOP MUSEUM, HONOLULU, HI, <i>Evaluation of the Bishop Museum's Science on a Sphere</i>	12

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MARYLAND SCIENCE CENTER	12
<i>Science on a Sphere Front-End Evaluation (Draft Report)</i>	12
<i>Formative Evaluation of Science on a Sphere, Supplemental Interpretive Components at the Maryland Science Center (Draft)</i>	13
<i>Summative Evaluation of the SOS Kiosk at Maryland Science Center</i>	14
MCWANE SCIENCE CENTER, BIRMINGHAM, AL, <i>McWane Assessment Summary I (Pre-test/Post-test) and II (Visitor/Public Survey)</i>	15
NAUTICUS NATIONAL MARITIME CENTER, <i>Science on a Sphere</i>	15
SCIENCE MUSEUM OF MINNESOTA	15
<i>Science on a Sphere Front-End Evaluation Report</i>	15
<i>Science on a Sphere Formative Evaluation Report</i>	16
<i>Footprints: Tracking Report</i>	17
<i>Footprints: Exit Interview Report</i>	17
<i>Science on a Sphere Lobby Interview Report</i>	18
<i>Science on a Sphere – Interpretive Features: Prototyping Report</i>	18
THE TECH MUSEUM OF INNOVATION, SAN JOSE, CA, <i>Exhibition Evaluation: Summative Evaluation of “Green by Design” and “View from Space”</i>	19
APPENDICES	21
Appendix One: Tables from THE TECH MUSEUM OF INNOVATION’S <i>Summative Evaluation of “Green by Design” and “View From Space”</i>	22
Appendix Two: Pictures of Easy-On-Easy-Off Benches	24

INTRODUCTION

1. Background

In October of 2008, the Denver Museum of Nature & Science (DMNS) proposed increasing awareness of comparative planetology and climate science using Science On a Sphere (SOS). SOS is a large, bright, flexible spherical display system developed by the National Oceanic and Atmospheric Administration (NOAA) that is perfectly suited to help visitors visualize and learn about topics such as these. Included in the proposal was the description of a comprehensive evaluation plan, including a process evaluation as well as front-end, formative, remedial, and summative evaluations. This literature review is an important component of the front-end evaluation. Questions to be answered in the review include, “How can we best convey the data sets to visitors? What mechanisms would be helpful? Should experiences be facilitated, and if so, how?”

2. The Literature

Science On a Sphere is currently installed at 48 sites around the world, and many of the sites participate in NOAA’s User’s Collaborative Network. The Network shares information content, content management, technical improvements, and various ways that users utilize the Sphere. In addition, the Network shares evaluation reports about the effectiveness of SOS for delivering content. Six institutions³ are currently participating in this aspect of the Network’s efforts, and have generated a total of 13 reports. The reports include everything from front-end evaluations to summative evaluations. Some focus on very particular aspects of the SOS system (e.g., computer kiosks) and others are more general. Surveys, interviews, observations, and tracking and timing were all used to collect data within this set of reports. The reports vary in length and in the quality of data collection, analysis, and reporting. Despite these variations, each report has useful information to contribute to this literature review.

3. How to Use This Literature Review

This document is divided into two sections.

The first section presents themes that emerged in the reading of the 13 reports. These include “Logistics,” “Labeling,” “Making the Data Engaging,” “Learning,” and “Beyond the Data Sets.” Each of these five themes encompass between two and seven topics. Each topic is illustrated with examples gleaned from one or more of the reports. If the reader wishes to learn more about the context of any example, she or he can flip to Section Two of the report. All examples are synthesized and paraphrased from the evaluation reports, unless a direct quotation is indicated.

Section Two describes the evaluation reports themselves, briefly describing the purpose and methods of the evaluation and listing the major findings in synthesized and paraphrased form. These are presented in alphabetical order by institution.

³ The Bishop Museum in Honolulu, the Maryland Science Center, McWane Science Center in Birmingham, AL, Nauticus/The National Maritime Center in Norfolk, VA, the Science Museum of Minnesota, and the Tech Museum of Innovation in San Jose, CA. See http://www.oesd.noaa.gov/network/SOS_evals/index.html for details.

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If the reader wishes to go straight to a particular theme or topic, or to one of the six institutions or 13 reports, the Table of Contents is a helpful place to start.

For the most part, the information in this document speaks for itself. In just a few cases the data begs for additional recommendations; those are provided by the author in footnotes.

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SECTION ONE: THEMES FROM THE EVALUATION REPORTS

1. LOGISTICS

a. Seating is a very important factor for visitor comfort and retention.

Slightly over half (57%) of the observed visitors took advantage of the open seating, and as a group, they tended to stay longer (median 6 minutes 37 seconds in contrast to the 40 second median time of the non-sitters). (Science Museum of Minnesota, "Footprints: Tracking Report")

More than half (60%) of the visitors sat down to watch the visualizations. Sitting typically more than doubled the time spent watching the Sphere. (E.g., median time for non-sitters was two minutes 12 seconds; time for sitters was 5 minutes 54 seconds.) (Science Museum of Minnesota, "Science on a Sphere: Formative Evaluation Report")

The projector stands acted as unintended benches for visitors. A few visitors commented that they would like seats all around, or "better seating." (Maryland Science Center, "Science on a Sphere Front-End Evaluation")

Recommendations for improving a live presentation on global warming and a 25-minute science module included maximizing audience attention by offering sufficient seating. (Bishop Museum, "Evaluation of the Bishop Museum's Science on a Sphere")

b. People need a reason to walk around the Sphere and cues telling them how.⁴

Over half (52%) of the visitors circled less than half of the Sphere. Most of these (81% of the 52%) identified particular reasons for not circling the Sphere, including lack of interest, time constraints, the need to follow children, or the expectation that the Sphere would turn to them – which in some cases it did. (Science Museum of Minnesota, "Science on a Sphere: Formative Evaluation Report")

Visitors were asked if they found anything about the Sphere confusing. Less than half of them did, but among those who experienced confusion, about half of the comments related to "where to stand." (Science Museum of Minnesota, "Science on a Sphere: Front-End Evaluation Report")

c. People want to see the top of the Sphere.

Some visitors asked for the image to be rotated so that all sides could be seen, or to bring the poles to the side. A few said that they would like to see the Northern Hemisphere with greater ease and suggested moving the Sphere closer to the floor. (Maryland Science Center, "Science on a Sphere Front-End Evaluation (Draft Report)")

Many visitors suggested that the exhibit be improved by helping visitors see what was on top of the Sphere. (Science Museum of Minnesota, "Science on a Sphere Front-End Evaluation Report")

When asked if the museum could change anything about the exhibit, one recommendation was to make it easier to see the top of the Sphere. (Science Museum of Minnesota, "Science on a Sphere Formative Evaluation Report")

d. Poor audio is frustrating and reduces learning.

When asked if the museum could change anything about the exhibit to help them better understand what they were viewing on the Sphere, visitors mentioned the poor quality of the audio most frequently. (Science Museum of Minnesota, "Science on a Sphere Formative Evaluation Report")

⁴ Since people want to sit but may learn more if they move around, easy-on-easy-off benches are an option. (See pictures in Appendix Two.) -MM

Among those visitors who had a negative reaction to the film, difficulty hearing the audio was cited as a reason. (Science Museum of Minnesota, "Footprints: Exit Interview Report.")

Comments in the interviews included a suggestion that the sound be improved. (McWane Science Center, "McWane Assessment Summary I (Pre-test/Post-test) and II (Visitor/Public Survey)")

e. On one hand, nearby distractions may reduce viewing time. On the other hand, placing the Sphere near foot traffic may increase participation.

Of those visitors who left early, one suggested that the museum could have fewer distractions to encourage people to stay longer. (Science Museum of Minnesota, "Footprints: Exit Interview Report")

Most of the people who reported visiting the Sphere said they did not seek it out; they just happened to come across it. (Science Museum of Minnesota, "Science on a Sphere Lobby Interview Report")

f. If the images on the Sphere move too quickly, people have trouble absorbing information.

When visitors were asked to pick their preferred speed of rotation, about half (47%) of them preferred the slower sample, 14% preferred the fast sample, and more than a third (39%) preferred a speed between the two samples. Their reasons for preferring the speed they chose indicated a desire to absorb the information presented without losing interest. (Science Museum of Minnesota, "Science on a Sphere – Interpretive Features: Prototyping Report")

About one-third of visitors said that they found something confusing about the film, and about one-third of those cited the rapid rate of image change. (Science Museum of Minnesota, "Footprints: Exit Interview Report")

There was a wide range of responses when asked if the speed of the images on the Sphere should be changed. A few visitors mentioned the value of repeating or stopping animations (which the presenters did). (Maryland Science Center, "Science on a Sphere Front-End Evaluation (Draft Report)")

2. LABELING

a. Labels on the Sphere – or the railings, or the wall - are helpful. Useful labels include color-keys, labels that identify items described in the audio, and “you are here” arrows.

When asked if the museum could change anything about the exhibit to help them better understand what they were viewing on the Sphere, some visitors suggested labels on the railing or on the Sphere. (Science Museum of Minnesota, "Science on a Sphere Formative Evaluation Report")

About one-third of the visitors said that additional labels on the Sphere would make it easier to understand. Some suggested that arrows be used to identify the area being referred to by the audio.

...Kiosk computer users appreciated the key, which explained the colors on the Sphere.

(Maryland Science Center, "Formative Evaluation of Science on a Sphere, Supplemental Interpretive Components at the Maryland Science Center (Draft)")

Three-quarters of visitors liked having the identification labels directly on the Sphere; a quarter would prefer the labels somewhere else in the exhibit area.

...Visitors wanted information about specific features (e.g. arrows pointing to things like the eye of Jupiter, glaciers, mountains, and “you are here” arrows).

...When the visualizations showed planetary bodies accompanied by labels with the names of those bodies, half of the visitors wanted additional labels with more information. When the visualization showed special features like Hurricane Katrina, there was a low interest in seeing additional labels indicating continents and oceans, or other pieces of information.

(Science Museum of Minnesota, “Science on a Sphere – Interpretive Features: Prototyping Report”)

b. Since labels may interfere with the realism of the projected image or provide too much information, people appreciate when they fade out.

When visitors were asked to rate their interest in potential kinds of interactivity with the Sphere, they expressed the most interest in seeing temporary labels on the Sphere. There was some concern about the labels ruining the visualization. (Science Museum of Minnesota, “Science on a Sphere: Front-End Evaluation Report”)

Most visitors wanted the label to disappear after a period of time, rather than having it remain the entire time the image was displayed.

...The reason that some visitors did not want additional labels - and the reason that most visitors wanted the basic labels to fade - was that they wanted to see the image in a realistic way without the distraction of too much information.

(Science Museum of Minnesota, “Science on a Sphere – Interpretive Features: Prototyping Report”)

c. Labels with questions to consider or teasers about upcoming shows keep people engaged.

Some labels included questions for visitors to think about as they viewed an image. Of the visitors who were observed viewing images that had questions on the label, about one-quarter of them (26%) said that they saw the questions. When these visitors were asked if the questions improved their experience, a majority of them (60% of the 26%) said it did. Most of these commented on how the questions made them look for images or think more deeply about what they saw.

...Labels were projected on the wall and they indicated what image would be playing next. Most (82%) of the visitors were observed reading the label. A little over half (58%) noticed the text that indicated what image was playing next. Of these, almost half (46% of the 58%) said they waited to see a particular image because they noticed it was next.

(Science Museum of Minnesota, “Science on a Sphere: Formative Evaluation Report”)

3. MAKING THE DATA ENGAGING

a. Scripted live presentations which allow room for audience participation engage visitors.

In general, live presenters who had a script but could respond to the specific needs of the group were very well received. Visitors appreciated having a live presenter and found it helpful for focusing. Teachers appreciated the way that presenters tailored the content to the group and promoted interactivity.

...A few visitors said that they were initially confused by a visual, but that the facilitator had explained things to their satisfaction.

...Most visitors would move around the Sphere when the presenter asked them to.

(Maryland Science Center, "Science on a Sphere Front-End Evaluation (Draft Report)")

Recommendations for improvement of a live presentation on global warming and a 25-minute science module included maximizing audience attention by increasing audience participation. (Bishop Museum, "Evaluation of the Bishop Museum's Science on a Sphere")

Information that was presented by the Center's educators received the lowest scores in a five-question survey, suggesting the need to have the SOS program scripted. (Nauticus National Maritime Center, "Science on a Sphere")

b. When staff invite visitors to use computer kiosks, they explore more topics and participate more fully with their children.

Most (70%) of the visitors who used the trackball kiosk on their own ("natural users") viewed one or two of the six topics; most (77%) of the visitors who were invited to use the kiosk by staff viewed three or more topics. Invited visitors were more likely than natural users to explore options under each topic, and they participated more fully with their children than natural users. (Maryland Science Center, "Summative Evaluation of the SOS Kiosk at Maryland Science Center")

c. People like being able to manipulate images on the Sphere or in their kiosk; sometimes this can be complicated.

Many of the trackball users explored screens other than that which was being shown on the Sphere. They liked the interactivity and the fact that they could choose what to explore. (Maryland Science Center, "Formative Evaluation of Science on a Sphere, Supplemental Interpretive Components at the Maryland Science Center (Draft)")

The most engaging features of the kiosk program were the interactive games, especially "Create a Hurricane" and "The Polar Bear Game." (People who clicked multiple features and/or spent a lot of time at a particular screen were considered more engaged.)

...Among the "natural" (i.e. not invited) users of the trackball computer kiosk, 80% were family groups with children, and the children – especially the boys – were the ones controlling the trackball and the button.

(Maryland Science Center, "Summative Evaluation of the SOS Kiosk at Maryland Science Center")

Telephone interviewees who used the "View from Space" kiosk reported that they enjoyed manipulating the Sphere's display. A couple of people said they had difficulty with the kiosk (with its use, content, or how it related to the Sphere). (The Tech Museum of Innovation, "Exhibition Evaluation: Summative Evaluation of 'Green by Design' and 'View from Space'")

Visitors were asked to rate their interest in potential kinds of interactivity with the Sphere. They were most interested in selecting images to be displayed on the Sphere. There was some concern about the effects of more than one person controlling images at a time. (Science Museum of Minnesota, "Science on a Sphere: Front-End Evaluation Report")

d. People like seeing things that relate to their direct experience.

Images with which the visitors could relate, e.g. the formation of a hurricane which had recently hit the region, engaged visitors. (Maryland Science Center, "Science on a Sphere Front-End Evaluation (Draft Report)")

Visitors wanted information about specific features including “you are here” arrows. (Science Museum of Minnesota, “Science on a Sphere – Interpretive Features: Prototyping Report”)

e. Young children tend to keep people away – and pull them away – from the Sphere.⁵ However, children stay longer when they can use interactive computer kiosks.

If visitors knew about SOS but didn’t visit it, it was typically because they lacked time and/or were with children. (Science Museum of Minnesota, “Science on a Sphere Lobby Interview Report”)

Most of the visitors who left early (11 of the 57 visitors left early) did so because they were with young children. (Science Museum of Minnesota, “Footprints: Exit Interview Report”)

Very young children tended to not want to stay and watch. (Maryland Science Center, “Science on a Sphere Front-End Evaluation (Draft Report)”)

Children ages three to seven – with or without adults – did not spend significantly less time using the kiosk than adult-only groups. (Maryland Science Center, “Summative Evaluation of the SOS Kiosk at Maryland Science Center”)

4. LEARNING

a. In general, people learn new information from seeing SOS and participating in related programs/activities.

For all of the classes tested, there was a statistically significant positive difference between the pre-test (average score 54%) and the post-test (average score 70%). (McWane Science Center, “McWane Assessment Summary I (Pre-test/Post-test) and II (Visitor/Public Survey)”)

...Based on an analysis of open-ended responses to questions about what the Sphere was showing, most visitors showed an improved understanding of the Sphere after using the kiosk or trackball computers. (Maryland Science Center, “Formative Evaluation of Science on a Sphere, Supplemental Interpretive Components at the Maryland Science Center (Draft)”)

When asked what they felt the movie “Footprints” was trying to show, almost all (95%) of the visitors were able to articulate an answer, with “solar system” being the most popular answer (51%) and “earth” being the next most popular (26%). (Science Museum of Minnesota, “Footprints: Exit Interview Report”)

About three-quarters of the visitors interviewed by phone were able to describe an environmental message when asked what they had learned about global climate change, technology, and environmental conservation. (The Tech Museum of Innovation, “Exhibition Evaluation: Summative Evaluation of ‘Green by Design’ and ‘View from Space’”)

b. Prior familiarity with a topic contributes to understanding.

Nearly everyone interviewed felt they were familiar with some of the topics (especially the sun and hurricanes) before using the kiosk, which helped them understand it more. (Maryland Science Center, “Summative Evaluation of the SOS Kiosk at Maryland Science Center”)

When asked what they thought the exhibit was trying to show, most answers were related to people’s prior familiarity with the images. (Science Museum of Minnesota, “Science on a Sphere Formative Evaluation Report”)

When asked what they had learned about technology, environmental conservation, and green design, most people said that they did not learn any new information, but some said they

⁵ Nearby play-areas or manipulatives to keep younger children occupied may alleviate this. -MM

developed more understanding of specific topics (e.g. compact florescent bulbs, regenerative braking). (The Tech Museum of Innovation, "Exhibition Evaluation: Summative Evaluation of 'Green by Design' and 'View from Space'")

c. Comprehension of data can be categorized into different levels, e.g. "big ideas," "new understandings and knowledge" and "particular facts."⁶

When asked about what they learned, visitors cited big ideas ("the Earth is always changing"), mechanical explanations ("the world is liquid rock"), new understandings based on visualization of global views and of time and scale ("the Pacific Ocean covers nearly half the planet"), new knowledge based on visualization of significant events ("extinction of the dinosaurs...was photogenic...how the comet hit the earth...it was easier to understand"), and particular facts ("Mars has a North Pole made of ice"). (Maryland Science Center, "Science on a Sphere Front-End Evaluation (Draft Report)")

When queried about the facts presented in the programs, most of the visitors answered correctly. (McWane Science Center, "McWane Assessment Summary I (Pre-test/Post-test) and II (Visitor/Public Survey)")

Most (85%) of the people interviewed could articulate specific information that they had learned or better understood after using the kiosk. (Maryland Science Center, "Summative Evaluation of the SOS Kiosk at Maryland Science Center")

...When the telephone interviewer(s) asked what ideas they gleaned from their experiences in the exhibitions and presentation (if they attended it), most of the responses related to specific information learned from specific exhibits, rather than a holistic sense from the exhibition as a whole. (The Tech Museum of Innovation, "Exhibition Evaluation: Summative Evaluation of 'Green by Design' and 'View from Space'")

d. Comprehension doesn't necessarily lead to application of knowledge.

Several visitors credited their visit with heightening their awareness of environmental issues or reinforcing existing pro-conservation behavior; most said they hadn't taken any new actions to address environmental issues since their visit. (The Tech Museum of Innovation, "Exhibition Evaluation: Summative Evaluation of 'Green by Design' and 'View from Space'")

e. Lack of cohesive storylines, insufficient explanations, confusing images and distractions can be barriers to learning.

Few visitors articulated one of the major objectives of SOS, an increased understanding of basic global cause-and-effect processes. The report states, "The fact that there is not a cohesive storyline for each of the playlists or between the three playlists may account for this lack of deeper understanding." (Science Museum of Minnesota, "Science on a Sphere Formative Evaluation Report")

Among those visitors who had a negative reaction to the film, lack of explanation about the content was cited as a reason. About one-third of visitors said that they found something confusing about the film, and about one-half of those cited confusion with particular images. (Science Museum of Minnesota, "Footprints: Exit Interview Report")

⁶ Although none of the reviewed reports took this approach, it may be useful to think in terms of Bloom's Taxonomy, a classic categorization of learning objectives presented by Benjamin Bloom in 1956. Some people pick up factoids, and so demonstrate "knowledge" as defined by Bloom. Others are able to articulate cause-and-effect processes ("comprehension"), or can compare and contrast what they see ("analysis" and "synthesis.") -MM

Trackball users were less likely than kiosk users to say that the element they were using helped them better understand what was on the Sphere. This is possibly due to the fact that they explored screens other than that which was being shown on the Sphere. (Maryland Science Center, "Formative Evaluation of Science on a Sphere, Supplemental Interpretive Components at the Maryland Science Center (Draft)")

5. BEYOND THE DATA SETS

a. People are very interested in how the images are projected on the Sphere.

When asked, "Tell me one or two things you found most interesting about the Sphere," 40% of those interviewed referred to the exhibit's technology, (e.g., the projection system, the fact that one can walk around it and that it looked like it was floating). (Science Museum of Minnesota, "Science Museum of Minnesota Science on a Sphere Front-End Evaluation Report")

Almost half (46%) of the visitors wanted to know more about the Sphere's technology (e.g., how the projection works). (Science Museum of Minnesota, "Science on a Sphere Formative Evaluation Report")

Visitors wanted to know more about the technology of the projection system of the Sphere. (Maryland Science Center, "Formative Evaluation of Science on a Sphere, Supplemental Interpretive Components at the Maryland Science Center (Draft)")

b. Aesthetic, affective, and attachment responses are not unusual.⁷

When asked to share additional comments, almost half (47%) of the visitors commented on the affective experience of seeing the Sphere. (Science Museum of Minnesota, "Science on a Sphere: Front-End Evaluation Report")

Additional comments by children in the interviews included two that showed an emotional attachment to the Sphere: "I wish I had one at home," and "I want one for my birthday." (McWane Science Center, "McWane Assessment Summary I (Pre-test/Post-test) and II (Visitor/Public Survey)")

When asked "what most impressed you about the Sphere?" visitors' responses related to the innovative technology, the aesthetic experience, and the versatility as an educational tool. One adult said, "It's beautiful" and a child commented, "I want to come for my birthday." (Maryland Science Center, "Science on a Sphere Front-End Evaluation (Draft Report)")

⁷ Mini-SOS gift shop items may have appeal. -MM

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SECTION TWO: EVALUATION REPORTS FROM THE NOAA USERS' COLLABORATIVE NETWORK

BISHOP MUSEUM, HONOLULU, HI

Evaluation of the Bishop Museum's Science on a Sphere

Pacific Resources for Education and Learning

October, 2007

In an evaluation conducted by Pacific Resources for Education and Learning (PREL) for the Bishop Museum in Honolulu, evaluators wanted to know about **the effectiveness of a 20-minute live presentation on global warming**. In their evaluation, they conducted a post-presentation written survey with 29 adults, interviews with 13 adults, and a one-week follow up telephone interview with six adults. They also **studied the effectiveness of a 25-minute science module with K-8 students**. To determine this, they analyzed samples of test results from various grade levels, compared Hawaii Department of Education science benchmarks for each grade level to the corresponding presentation scripts and tests, and conducted telephone interviews with six teachers representing different grade levels. They found that **the live presentation was in fact an effective tool for teaching the public about global warming**, and that the **science modules presented to school groups did in fact add value to teachers' coverage** of the intended benchmarks, and were effective in producing learning. Most useful for the purposes of this literature review were **recommendations for improvement**, which included **maximizing audience attention by:**

1. **Decreasing traffic flow,**
2. **Offering sufficient seating,**
3. **Accommodating multiple viewing angles, and**
4. **Increasing audience participation.**

MARYLAND SCIENCE CENTER

The Maryland Science Center conducted three evaluations related to Science on a Sphere.

Science on a Sphere Front-End Evaluation (Draft Report)

Alice Apley, RMC Research Corporation

August 20, 2004

In the front-end evaluation conducted by RMC Research Corporation for the Maryland Science Center, evaluators used interviews and surveys to learn **how people felt and what they learned in response to the placement of the Sphere in the museum, the data on the Sphere, and the interpretive program scripts**. The interviews were conducted with groups of students from school groups and their teachers and parents. Surveys were completed by visitors representing the general public. In general, **live presenters who had a script but could respond to the specific needs of the group were very well received**. The following was learned:

1. **Visitors appreciated having a live presenter and found it helpful for focusing.** Teachers were impressed at the students' level of engagement and appreciated the way that presenters tailored the content to the group and promoted interactivity.
2. Visitors found the presentation to be very clear. **A few visitors said that they were initially confused by a visual, but that the facilitator had explained things to their satisfaction.**
3. **Images with which the visitors could relate**, e.g. the formation of a hurricane which had recently hit the region, **engaged visitors.**

4. When asked “what most **impressed** you about the Sphere?” visitors’ responses related to the **innovative technology, the aesthetic experience, and the versatility** as an educational tool. “It’s beautiful,” was one comment. Another (from a child) was, “I want to come for my birthday.”
5. When asked about what **they learned**, visitors cited **big ideas** (“the Earth is always changing”), **mechanical explanations** (“the world is liquid rock”), **new understandings based on visualization of global views and of time and scale** (“the Pacific Ocean covers nearly half the planet,” “I never realized the degree of movement of the continents”), **new knowledge based on visualization of significant events** (“extinction of the dinosaurs...was photogenic...how the comet hit the earth...it was easier to understand”), and **particular facts** (“Mars has a North Pole made of ice”).
6. People used the **projector stands as benches**, and a few visitors commented that they **would like seats all around**, or “better seating.”
7. Most visitors would **move around the Sphere when the presenter asked** them to.
8. **Very young children tended to not want to stay** and watch.
9. There was a **wide range of responses** when asked if the **speed of the images** on the Sphere should be changed. A few visitors mentioned the **value of repeating or stopping animations** (which the presenters did).
10. Some **visitors asked** for the image to be rotated so that **all sides could be seen**, or to bring the poles to the side. A few said that they would **like to see the Northern Hemisphere with greater ease**, and suggested moving the Sphere closer to the floor.

*Formative Evaluation of Science on a Sphere, Supplemental Interpretive Components at the Maryland Science Center (Draft)
People, Places & Design Research
June, 2007*

Ninety-nine adults and children participated in this study, which focused on people’s **perception of interpretive messages and their reactions to** one of two elements intended to better help them understand the content on the Sphere: **kiosk or trackball computers**. Visitors were also asked for suggestions about making the Sphere easier to understand and more interesting, and they were asked what else they’d like to know about the Sphere. Findings were as follows:

1. Initially, about **half of the adults and one-quarter of the children expressed a clear understanding of what was being shown on the Sphere**. This pattern corresponds to their self-report about how easy it was to understand what was on the Sphere.
2. About one-third of the visitors said that **additional labels on the Sphere would make it easier to understand**. Some suggested that arrows be used to identify the area being referred to by the audio, and some suggested that the image rotate so that people didn’t have to walk around it.
3. Based on an analysis of open-ended responses to questions about what the Sphere was showing, **most visitors showed an improved understanding of the Sphere after using the kiosk or trackball computers**. Among those who didn’t understand the Sphere initially, 86% of kiosk users and 74% of trackball computer users showed improvement (this difference was not statistically significant).
4. Many of the **trackball users** explored screens other than that which was being shown on the Sphere. They were less **likely than kiosk users to say that the element they were using helped**

them better understand what was on the Sphere. That being said, they liked the interactivity, and the fact that they could choose what to explore.

5. The main complaint from trackball computer users was that it was hard to understand how to use it at first; this was especially true for children who didn't understand the word "cursor" in the instructions. People thought **a touch screen was easier than a trackball.**
6. **Kiosk computer users appreciated the key, which explained the colors on the Sphere,** and liked that the kiosk was easy to understand. On the other hand, they didn't like the fact that the image didn't move, and wanted more interactivity. They appreciated the labels that existed and wanted more.
7. **Visitors wanted to know more about** the technology of **the projection** system of the Sphere.

*Summative Evaluation of the SOS Kiosk at Maryland Science Center
People, Places & Design Research
February, 2010*

Staff invited 100 visitor groups to use the **computer trackball kiosk**,⁸ observed them while they did so, and then interviewed them. In addition, they conducted naturalistic observations with 243 visitor groups who used the kiosk on their own. This research was conducted to **evaluate visitors' use and perceptions** of the computer kiosk. Findings were as follows:

1. **Most (70%) of the visitors who used the trackball kiosk on their own** ("natural users") **viewed one or two** of the six topics; **most (77%) of the visitors who were invited** to use the kiosk by staff **viewed three or more topics.** Invited visitors were more likely than natural users to explore options under each topic.
2. **Invited visitors participated more fully with their children** than natural users.
3. Among the natural users, 80% were family groups with children, and the children – especially the **boys** – were the ones **controlling the trackball and the button.**
4. Among the natural users, **children ages three to seven** – with or without adults – **did not spend significantly less time** using the kiosk **than adult-only groups.**
5. In general there were **no statistically significant differences between adults and children** in either group, in terms of **how many topics they viewed or which** topics they viewed.
6. Nearly everyone among the **invited users** felt they were **familiar with some of the topics** (especially the sun and hurricanes) **before using the kiosk,** which **helped them understand it more.** **Most (85%) of the invited visitors could articulate specific information that they had learned** or better understood after using the kiosk (e.g. the factors that affect hurricane formation, or that Mars has clouds).
7. The **most engaging features of the kiosk program were the interactive games,** especially "Create a Hurricane" and "The Polar Bear Game." (People who clicked multiple features and/or spent a lot of time at a particular screen were considered more engaged.)
8. Visitors who were interviewed liked learning new information, the interactivity, and the visual images.

⁸ From my interpretation, the Maryland Science Center evaluated two systems ("trackball computer" and "kiosk computer") for its formative evaluation of supplemental interpretive components, and then evaluated one system (titled "trackball computer kiosk") in its summative evaluation. My guess is that "trackball computer" is the same as "trackball computer kiosk." -MM

MCWANE SCIENCE CENTER, BIRMINGHAM, AL

McWane Assessment Summary I (Pre-test/Post-test) and II (Visitor/Public Survey)

Author Unknown

Estimated February 2007

The McWane Science Center conducted pre-tests and post-tests with a total of 27 classes from local elementary and middle schools. The classes had attended either “Our Place in Space” or “Active Atmosphere.” In addition, 39 participants in the “Earth and Beyond” program and 40 participants in the “Journey to Mars” program were asked a series of general and content questions, and were asked for additional questions and comments. Findings were as follows:

1. For all of the classes tested, **there was a statistically significant positive difference between the pre-test** (average score 54%) **and the post-test** (average score 70%).
2. Among the “Earth and Beyond” participants, virtually all felt that the Science on a Sphere enhanced their visit, made a complex topic more understandable, and most felt as if they learned or gained knowledge.
3. Additional comments in the interviews related to general positive feedback, and **a suggestion that the sound be improved**. Two comments reflected an emotional attachment to the Sphere: “I wish I had one at home,” and “**I want one for my birthday.**”
4. When **queried about the facts** presented in the programs, **most of the visitors answered correctly**.

NAUTICUS NATIONAL MARITIME CENTER

Science on a Sphere

Martin Fisher

January 25, 2007

Seventy-eight visitors completed a five-question survey after educational public programs. Findings were as follows:

1. Visitors had a high level of appreciation and comprehension. (The lowest score marked was a “3” on a scale of “1” (“terrible”) to “5” (“excellent”).)
2. Information that was presented by the Center’s educators received the lowest scores, suggesting **the need to have the SOS program scripted**.
3. Visitors said they did not learn much new information from the program, and thought they already knew the concepts and information; the evaluator did not believe this to be true.

SCIENCE MUSEUM OF MINNESOTA

The Science Museum of Minnesota conducted six evaluations related to Science on a Sphere.

Science on a Sphere Front-End Evaluation Report

Amy Grack Nelson and Kirsten Ellenbogen

May 25, 2006

In this **front-end evaluation** for the Science Museum of Minnesota, evaluators collected **baseline information about how visitors reacted to and comprehended SOS**, specifically a series of four narrated NOAA visualizations (“Blue Planet,” “Topographic Earth,” “Wild Fire,” and “Earth at Night”). Visitors were also asked **what they would like from SOS in terms of content and interactivity**. Eighty-one visitors were observed, and 50 of these were interviewed. The following themes emerged:

1. When asked, “Tell me one or two things you found most interesting about the Sphere,” **40% of those interviewed referred to the exhibit’s technology** (e.g., the projection system, the fact that one can walk around it, and that it looked like it was floating).
2. When asked if they found anything about the Sphere confusing, **52% of interviewees said they were confused about where to stand**.
3. Visitors were asked to rate their interest in three potential kinds of interactivity with the Sphere. **They were most interested in selecting images or temporary labels** (e.g. countries, or images described in the narration) **to be displayed on the Sphere. There was some concern about the labels ruining the visualization, and about the effects of more than one person controlling images at a time**.
4. When asked to share additional comments, **almost half (47%) of the visitors commented on the affective experience of seeing the Sphere**.
5. **Many visitors suggested that the exhibit be improved by helping visitors see what was on top of the Sphere**.

Science on a Sphere Formative Evaluation Report
Amy Grack Nelson
July 2006

In this **formative evaluation** for the Science Museum of Minnesota, evaluators gathered feedback on several **new exhibit features, including an expanded playlist, accompanying labels projected on the wall, seating for visitors**, and new audio for some visualizations. Fifty visitors were observed and interviewed. The following themes emerged:

1. **Visitors watched SOS longer** than they had in the front-end evaluation. (E.g., median time increased from 3 minutes to 3 minutes 29 seconds.)
2. **Most (82%) of the visitors were observed reading the label**. (Labels were projected on the wall and they described the visualization and indicated what image would be playing next.) A little over half (58%) noticed the text that indicated what image was playing next. Of these, almost half (46% of the 58%) said **they waited to see a particular image because they noticed it was next**.
3. Some labels included questions for visitors to think about as they viewed an image. **Of the visitors who viewed images that had questions on the label, about one-quarter of them (26%) said that they saw the questions**. When these visitors were asked if the questions **improved their experience**, a majority of them (60%) said it did. Most of these commented on how the questions made them look for images or think more deeply about what they saw.
4. More than half (60%) of the visitors sat down to watch the visualizations. **Sitting typically more than doubled the time spent watching the Sphere**. (E.g., median time for non-sitters was two minutes 12 seconds; time for sitters was 5 minutes 54 seconds.)
5. **Over half (52%) of the visitors circled less than half of the Sphere. Most of these (81% of the 52%) identified particular reasons for not circling the Sphere**, including lack of interest, time

constraints, the need to follow children, or the expectation that the Sphere would turn to them – which in some cases it did.

6. **Almost half (46%) of the visitors wanted to know more about the Sphere’s technology** (e.g., how the projection works).
7. When asked if the museum could change anything about the exhibit to help them better understand what they were viewing on the Sphere, visitors mentioned the **poor quality of the audio** most frequently. Other visitors suggested **labels on the railing or on the Sphere**. Another recommendation was to **make it easier to see the top of the Sphere**.
8. When asked what they thought the exhibit was trying to show, most answers were related to people’s **prior familiarity with the images**, such as solar systems and weather or climate. **Few visitors articulated one of the major objectives of SOS, an increased understanding of basic global cause-and-effect processes**. The report states, “The fact that there is not a cohesive storyline for each of the playlists or between the three playlists may account for this lack of deeper understanding.”

Footprints: Tracking Report

Amy Grack Nelson

January 15, 2007

This report addresses **how visitors viewed the NASA-produced film “Footprints,”** with the goal of informing the development of a future film. The film ran continuously, and 73 visitors were observed. Findings were as follows:

1. **Slightly over half (57%) of the visitors took advantage of the open seating, and as a group, they tended to stay longer** (median 6 minutes 37 seconds in contrast to the 40 second median time of the non-sitters.)
2. **“Footprints” was set up so that visitors could see the features of most images from where they were seated;** most (82%) stood or sat in one place rather than circle the Sphere.

Footprints: Exit Interview Report

Amy Grack Nelson, Beth Janetski, and Murphy Pizza

January 17, 2007

In this report, **feedback about the NASA-produced film *Footprints*** was gathered from fifty-seven visitors through interviews. Findings were as follows:

1. Almost all of the visitors (98%) enjoyed the movie.
2. Among the 28% of the visitors who had a negative reaction to the film, **lack of explanation about the content** was cited as a reason, as was **difficulty hearing the audio**.
3. The most interesting images in *Footprints* were solar system images (this was mentioned by 60% of the visitors) and earth images (37%).
4. About one-third (30%) of visitors said that they found something confusing about the film, with most of the responses related to **confusion with particular images (53%) and the rapid rate of image change (29%)**.
5. **Over half (56%) of the visitors wanted more information about something they saw in the film;** 40% of those visitors requested information about our solar system.

6. **When asked what they felt the movie was trying to show, almost all (95%) of the visitors were able to articulate an answer**, with “solar system” being the most popular answer (51%) and “earth” being the next most popular (26%).
7. Most of the **visitors who left early** (11 of the 57 visitors left early) did so because they **were with young children**. Of those 11 **visitors who left early**, two **had suggestions** for how the museum could change the movie so they would have stayed longer: **more seating and fewer distractions**.

Science on a Sphere Lobby Interview Report
Amy Grack Nelson and Beth Janetski
March 2, 2007

This report indicates **how many visitors saw SOS** during their visit to the museum, their **prior knowledge** about SOS, and **why they chose not to visit SOS**. One hundred eighty-nine visitors were interviewed. Findings were as follows:

1. About a quarter (26%) of the visitors interviewed reported visiting SOS. **Most** of these (92% of the 26%) said they **did not seek out SOS, they just happened to come across it**.
2. **Most of the visitors who did not stop at SOS had not heard of it**. Those who did not stop at SOS but had some familiarity with it had seen it during a prior visit or had simply glanced at it during their current visit. **If they knew about it but didn't visit it, it was typically because they lacked time and/or were with children**.
3. More than two-thirds of the visitors interviewed would see again.

Science on a Sphere – Interpretive Features: Prototyping Report
Amy Grack Nelson and Levi Weinhagen
March 29, 2007

In this report, fifty-one visitors were interviewed to learn about their **preferences related to the use of interpretive labels and graphic directly on the Sphere, and the speed** in which visualizations rotate. Findings were as follows:

1. **Three-quarters (75%) of visitors liked having the identification labels directly on the Sphere**; a quarter (25%) would prefer the labels somewhere else in the exhibit area.
2. **Most (94%) of the visitors wanted the label to disappear after a period of time**, rather than having it remain the entire time the image was displayed. The preferences were similar regarding labels highlighting special features like Hurricane Katrina (65% preferred that the graphic disappear after a period of time).
3. **When the visualizations showed planetary bodies** accompanied by labels with the names of those bodies, **half (49%) of the visitors wanted additional labels with more information**. For example, they wanted to know facts about the image (date of discovery of a planet, temperatures). They also wanted information about specific features (e.g., arrows pointing to things like the eye of Jupiter, specifics about ocean currents, trenches, air current, oceans, glaciers, mountains, and “you are here” arrows.)
4. **When the visualization showed special features** like Hurricane Katrina, **there was a low interest in seeing additional labels indicating continents and oceans, or other pieces of information**. (Sixty percent of visitors chose a rating between one and five on a 10-point scale)

about their interest in labels showing continents and ocean, and 74% did not indicate an interest in other types of information.)

5. **The reason that some visitors did not want additional labels** - and the reason that most visitors wanted the basic labels to fade - **was that they wanted to see the image in a realistic way without the distraction of too much information.**
6. When visitors were asked to pick their **preferred speed of rotation, about half** (47%) of the visitors **preferred the slower sample**, 14% preferred the fast sample, and **more than a third** (39%) **preferred a speed between the two samples.** Their reasons for preferring the speed they chose indicated **a desire to absorb the information presented without losing interest.**

THE TECH MUSEUM OF INNOVATION, SAN JOSE, CA

Exhibition Evaluation: Summative Evaluation of “Green by Design” and “View from Space”

Randi Korn & Associates, Inc.

May, 2008

The Tech Museum of Innovation launched two related exhibitions, “**Green by Design**” and “**View from Space**,” which, combined, included 25 exhibits. In an effort to document **the impact and effectiveness** of these, evaluators conducted a tracking and timing study of 100 drop-in visitors, interviewed 27 visitor groups, and conducted 50 follow-up interviews a few weeks after the interviewees’ visits. Their report included the following points:

1. Of the 100 visitors observed, 45% visited “View from Space” and 91% visited “Green by Design.”
2. Visitors spent the most time at the “MPG Marathon” computer interactive, and the least time at the “SELCO Solar Light” panel and artifact and the “Annual Award Celebrates Technology...” panel.
3. When asked what they had learned about technology, environmental conservation, and green design, **most people said that they did not learn any new information, but some said they developed more understanding of specific topics** (e.g. compact florescent bulbs, regenerative braking).
4. In the telephone interviews, visitors were reminded of the exhibitions’ location and general layout, and asked what they remembered from their visit. “Harnessing Energy,” one of four subsections of “Green by Design” was recalled by almost two-thirds of visitors; the “**View from Space**” **projection globe (Sphere) was mentioned by more than half of them.**
5. About one-quarter of telephone interviewees said they used the “**View from Space**” kiosk. They spoke about viewing **information about specific topics** (e.g. wind patterns, water currents), and **manipulating the Sphere’s display** (which was enjoyable). A couple of people said they had **difficulty with the kiosk** (with its use, content, or how it related to the Sphere).
6. One-third of interviews said they attended the “Global Climate Change” live presentation and most of them praised it.
7. When the telephone interviewer(s) asked **what ideas they gleaned** from their experiences in the exhibitions and presentation (if they attended it), **most of the responses related to specific information learned from specific exhibits, rather than a holistic sense from the exhibition as a whole.**

The material contained in this document is based upon work supported by NASA under grant award NNX09AL70G. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessary reflect the views of the National Aeronautics and Space Administration.

8. About **three-quarters of the visitors** interviewed by phone were **able to describe an environmental message**, when asked what they had learned about global climate change, technology, and environmental conservation.
9. Several visitors credited their visit with **heightening their awareness of environmental issues or reinforcing existing pro-conservation behavior**; most said they **hadn't taken any new actions** to address environmental issues since their visit.
10. Among the recommendations made in the report by the evaluators was the suggestion to **draw attention to the kiosk so that more visitors would know that they could use it to control the display on the Sphere** when live programs weren't taking place.

See Appendix One for related tables.

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APPENDICES

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Appendix One: Tables from THE TECH MUSEUM OF INNOVATION’S *Summative Evaluation of “Green by Design” and “View From Space”*

TABLE 9
TIME SPENT AT INDIVIDUAL EXHIBITS

EXHIBIT COMPONENT (n = 100)	NUMBER OF VISITORS WHO STOPPED	MEDIAN TIME (SEC.)
MPG Marathon computer interactive	18	85.0
Harnessing Energy panel	1	67.0
<i>View from Space</i> theater	42	58.5
<i>View from Space</i> kiosk	7	58.0
Supercapacitor interactive	33	58.0
Light Bulb interactive	17	51.0
Wind Station interactive	28	46.0
Water Station interactive	35	45.0
Solar Station interactive	39	42.0
Regenerative Braking interactive	26	31.0
Bright Ideas interactive	14	25.5
Electric Vehicle artifact and panel	37	25.0
Photovoltaic Cell/New Technologies Focus on Affordable Solar Panels three-sided panel	17	22.0
Save Energy at Home kiosk	7	21.0
KickStart panel and artifact	5	20.0
ABT Insulpanel/“Green” Insulation is a Natural Choice three-sided panel	6	16.0
Innovation and Technology Fuel the Future panel	34	15.5
Electric Motocross artifact	6	14.5
Hermannsburg, Australia Solar Dish graphic panel	2	13.5
Freeplay Foundation panel and artifact	4	9.5
Brunsbüttel Germany Wind Turbine graphic panel	3	8.0
Itaipu Brazil Dam graphic panel	3	7.0
SELCO Solar Light panel and artifact	6	5.5
Annual Award Celebrates Technology that Benefits Humanity panel	4	5.5
Tubular Skylight/Make the Switch to Energy Efficient Lighting three-sided panel	0	0.0

10 Randi Korn & Associates, Inc.

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TABLE 10
INDIVIDUAL EXHIBITS AT WHICH VISITORS STOPPED

EXHIBIT COMPONENT (<i>n</i> = 100)	% VISITORS WHO STOPPED
<i>View from Space</i> theater	42.0
Solar Station interactive	39.0
Water Station interactive	35.0
Innovation and Technology Fuel the Future introduction panel	34.0
Supercapacitor interactive	33.0
Wind Station interactive	28.0
Light Bulb interactive	17.0
Photovoltaic Cell/New Technologies Focus on Affordable Solar Panels three-sided panel	17.0
Bright Ideas interactive	14.0
<i>View from Space</i> kiosk	7.0
Save Energy at Home kiosk	7.0
ABT Insulpanel/"Green" Insulation is a Natural Choice three-sided panel	6.0
SELCO Solar Light panel and artifact	6.0
Electric Motocross artifact	6.0
KickStart panel and artifact	5.0
Annual Award Celebrates Technology that Benefits Humanity panel	4.0
Freeplay Foundation panel and artifact	4.0
Itaipu Brazil Dam graphic panel	3.0
Brunsbüttel Germany Wind Turbine graphic panel	3.0
Hermannsburg, Australia Solar Dish graphic panel	2.0
Harnessing Energy panel	1.0
Tubular Skylight/Make the Switch to Energy Efficient Lighting three-sided panel	0.0

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Appendix Two: Pictures of easy-on-easy-off benches (common at European bus stops)



(Credit: bleekism, on Flickr. <http://www.flickr.com/photos/bleekism/3133547952/>)