



Hatfield Marine Science Center

August, 2010

Magic Planet Installation Evaluation Findings

Shawn Rowe,
Oregon Sea Grant,
Oregon State University

Katie Stofer,
Oregon State University

Céleste Barthel,
Wilson College

Nancee Hunter,
Oregon Sea Grant,
Oregon State University





Oregon Sea Grant
Oregon State University
322 Kerr Administration Bldg.
Corvallis, OR 97331-2131
Phone: 541-737-2714
Fax: 541-737-7958
Web: <http://seagrant.oregonstate.edu>

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In 2008, Oregon Sea Grant (OSG) was awarded a NOAA Environmental Literacy grant to install, test, and develop evaluation rubrics for a Magic Planet spherical display system (<http://www.globalimagination.com/>). The Magic Planet is a sphere with an internal projection system that allows for spherical projection of earth systems data such as that often collected and used by ocean and earth systems scientists. In July of 2008, a one-meter Magic Planet was installed at Oregon State University's (OSU) Hatfield Marine Science Center Visitors Center (VC). Beginning immediately, base line use data were collected, recommendations were made for changes to the physical context and conceptual content of the exhibit and development of new materials was begun. Following a significant period of time during which electrical, hardware, and software issues were identified and addressed, basic formative evaluation continued in parallel with development of a suite of evaluation tools to allow for

visitor reflection on video of their interactions with the Magic Planet and its visualizations.

This document outlines front-end and formative evaluation findings related to the Magic Planet installation and use by public audiences. Details of the evaluation rubrics that were developed for Science on a Sphere (SOS) Network use are reported in a second document, Promoting Meaning Making at Spherical Display Systems: Evaluation Toolkit (Rowe, et. al., 2010).

Setting

The VC is located on the Pacific coast in Newport, Oregon as part of the OSU Marine Laboratory Campus. Oregon Sea Grant manages the VC as a donations-only public informal science education institution with approximately 150,000 visitors a year. VC exhibits feature live marine animals, in-



teractive activities, puzzles and games that demonstrate marine science concepts linked to marine and aquatic sciences research conducted in Oregon and the Pacific Northwest. Rhythms of our Coastal Waters (RCW) is an exhibit room at HMSC containing five exhibits sharing a remote sensing theme. RCW is intended to increase visitor awareness of remote sensing and content related to ocean and climate sciences. The Magic Planet is part of this exhibit space, which also includes an interactive touch screen involving plotting real time salinity data, a wind speed activity involving a computer plotting data from an anemometer manipulated by fans, an interactive exhibit on satellite and boat-based oceanography, and an interactive kiosk on coastal ocean and estuarine research.

Methods

Three phases of evaluation are reported on here: 1) a baseline study to establish basic use patterns after initial install; 2) formative studies aimed at improving attraction and holding power as well as interactivity, and 3) a formative study for improving interface design and understanding visitor meaning making.

Baseline Methods:

Baseline use data were collected via unobtrusive observations and exit interviews conducted by an undergraduate student intern and a graduate student attending at course at OSU on physical aspects of learning. A total of 130 groups were observed interacting with the Magic Planet for this round of data collection and 80 groups and 18 staff were interviewed.

Improving Attraction and Holding Power and Interactions Methods:

As part of formative evaluation work to improve time spent at the exhibit, number of people using the exhibit, and the quality of visitor-visitor interactions at the exhibit, unobtrusive focused observations and tracking were used. A total of 178 visitors were tracked and observed through three iterations of design including installation of a flat screen video monitor, installation of vinyl floor marks outside

the exhibit area, and small changes to the touch screen interactive (i.e., removal of one data set).

Improving Interfaces Methods:

Two versions of interactive kiosk were tested as part of our attempts to improve interfaces and support visitor meaning making with the exhibit. Evaluations of both included unobtrusive observations and video taping visitor groups followed by using the video for stimulated recall interviews. Actions, talk, and interactions of 39 individuals or groups using the first version of the kiosk were recorded with an observational protocol. Interaction with the exhibit in these cases was defined as 30 seconds or more dwell time and at least one selection at the kiosk of a new image for the globe. All visitor groups or individuals who interacted with the globe during the observation time were recorded, for a total of 134 persons in 39 groups.

In addition to several categories of actions, particularly types of questions asked, including those relating to content on the globe or the kiosk, or those related to procedure for interaction, such as what content to view, whether to flip the globe, or how to do something, the researcher also recorded pointing and other behaviors directed toward other group members, reading kiosk content aloud, and amount and types of talk about the content or other talk. For talk, we considered three general levels of engagement: exclamations or general statements of interest were taken as evidence of surface-level cognitive engagement; identification of places on the globe as mid-level cognitive engagement; and statements relating to content, statements that brought up prior knowledge or experiences, hypotheses, extensions and explanations as evidence of deeper cognitive engagement.

For the new kiosk, we videotaped 15 groups of two or more visitors using Video Traces software developed by Reed Stevens and colleagues at the University of Washington (Stevens & Hall, 1997; Stevens & Toro-Martell, 2003). Groups entering the exhibit area were approached to participate and after obtaining consent, they were asked to “use the exhibit/kiosk as they normally would.” After videotaping, all groups were interviewed using Video-



Traces to play back their video for them as a stimulated recall. The groups also had the option, thanks to the use of Video Traces, to use the computer mouse to point out particular choices they made and have this use of the mouse recorded on the interview video as an annotation. The interview audio was similarly “annotated” to the original video. The entire process, including visitor use of the exhibit and subsequent interview, lasted between fifteen and thirty minutes. A total of 43 people were video taped and interviewed over the 15 groups.

Findings

Baseline Use Data: People like the globe.

In July and August 2008, an undergraduate intern conducted front-end evaluation on basic use patterns and to determine the needs and backgrounds of our audience. The interactions of 120 individuals in 52 groups were observed. 40 visitors were interviewed using an informal open-ended interview protocol, and 18 staff interacting with the exhibit were observed. Findings included:

- Magic Planet was initially a huge attractor as a stand-alone exhibit and for the other exhibits in the room -- people seem to appreciate the whole experience, have many questions about the exhibit, and take many pictures of it.
- The data sets and kiosk interface with which Magic Planet was delivered had an acceptable average stay time of just over 3 minutes. This coincides with stay time for many of our interactive computer and video-based exhibits.
- The touch screen interactive promoted social interaction in the form of conversations among visitors and across visitor groups.
- Visitors were very confused about the source of images and what they represent because of the lack of context.
- About a third of visitors (38%) touched the globe when theatre-type barriers surrounded it. This reduced to zero when the new housing was built and installed.

- A trained docent can use the globe rather effectively to prompt open-ended discussions of ocean sciences and marine phenomena. The key to rich interactions between docent and visitors is in part the ability to choose among data sets to answer questions or guide discussions.
- Volunteer docents despite keen interest have serious difficulty using the globe as anything other than a touch point for discussion of content with which they are already familiar.

Improving Attraction and Holding Power

The RCW exhibit stands apart from the main flow of visitors at the VC. Observations by an OSU graduate student suggested that a number of factors could be affecting visitor use of the exhibit area, including:

- The separate doors seem to section the room off from the rest of the center, so visitors may not be sure whether they are “allowed” in there
- As RCW is at the end of the regular visitor route and near the exit, visitors may skip over it if their time is limited or as interest decreases towards the end of their visit, i.e. through museum fatigue (Falk & Dierking, 1992).
- The line of sight to the exit from the exhibits before RCW doesn’t easily include RCW, as it is a separate room off to the right.

As a result, less than a third of visitors (27%) who passed the door of the room entered. This contrasts with 98% of visitors stopping at the SOS installation at Science Museum of Minnesota. Attempts to use vinyl-flooring marks and barriers to attract visitors into the room raised the number of people entering modestly to 33%.

Once they are in the room, most people who enter interact with the Magic Planet. Early observations (n=78) indicated that 58% of people passing near the exhibit actually stopped to interact. Exit interviews (n=40) complicate the observational evidence with 50% of respondents saying that they had interacted with the Magic Planet. In exit interviews (n=40), when asked about what they liked best about the exhibit, 25% mentioned a specific image



or visualization (mostly hurricane images, followed by plate tectonic images). The remaining 75% talked about the globe in general without mentioning specific images or content. It is possible that many of these visitors saw the globe and even observed it from outside the room while the 25% who mentioned specific visualizations actually entered the room to interact. During the third phase of evaluation, 53% of visitors stopped to interact. Over the course of the evaluation, then, a little less than 1/3 of visitors to the VC entered the room containing Magic Planet and, once there, slightly more than half of them actually interacted with the exhibit.

Improving interactions: Addition of a second flat screen monitor.

In another attempt to draw more attention to the room containing the globe and to help create more interpretive context for exhibits, a 42" flat screen television mirroring the display of the touch screen interactive was installed on an external wall near the exhibit and in clear view from outside the room containing Magic Planet.

While the flat screen did not affect the number of people entering the room (it remained close to 27%), it did seem to attract more visitors to the Magic Planet once they entered the room with 85% of people who entered the room stopping to interact with the Magic Planet following installation of the flat screen (n=78). This change also seems to have had a small impact on holding power, increasing it to an average of just under four minutes. Thus, the flat screen was able to attract people to the Magic Planet, but the technology to maintain a constant feed to it from the computer associated with Magic Planet was unstable. It was eventually repurposed to include an exhibit on remote sensing and satellites and later to display satellite data on the extent of the Deep Water Horizon oil spill. On its repurposing, use of the Magic Planet by visitors entering the room returned to 53%.

Improving interactions: New user interfaces.

Beyond the original kiosk interface delivered with the Magic Planet, two kiosk designs were developed and tested during the evaluation. The first

kiosk was a simple full-screen html-based display with content organized into four themes: Earth's Dynamic Systems, Earth's Plate Tectonics, Global Events, and Solar System. Each theme contained several Earth systems science images or animations.

For each globe image, a few sentences of accompanying text described the images, sometimes noting the meaning of the colors used, as with El Niño, or outlining how or when the images were collected, as in the description of Hurricane Katrina, or describing the topic depicted more generally, as with volcanoes, which did not describe a specific volcanic eruption but simply depicted locations of active volcanoes around the world as well as tectonic plate boundaries. No globe image had more than a single paragraph of explanation, and no image was connected in a sequence with others besides the grouping into themes.

In addition to choosing content from the themes laid out across the top of the kiosk, the visitors could choose to control the position and speed of the image in several ways. The images could be rotated faster, slower, or stopped completely, and the animations could be played faster, slower, or stopped completely. The globe image could also be "flipped" so that the locations of the poles of Earth could be switched, allowing the visitor to view, for example, Antarctica, which is not visible most of the time due to the positioning of the lens that displays the images on the globe.

The re-designed kiosk started with text and architecture completely from scratch. The kiosk is now built on Macromedia Shockwave Flash. All controls for manipulating the image on the globe (rotation, animation speed, and flip poles) were removed, and only one menu with titles, rather than a menu leading to another level of choices before the explanatory text. The four new titles were: Recipe for a Hurricane, which features two globe images: hurricanes from 2005, including Katrina, and then 2004, including Ivan and explaining hurricane formation; El Niño, the same animation as before but with more explanatory text; Coral Bleaching, featuring two globe images: one of current sea surface temperatures that are thought to be warm enough to threaten coral, and one of human impact on the



ocean, including text on coral reefs as one of the most-human-affected ocean ecosystems; and finally Tsunami, which features simulated animations of the wave height and spread from the December 26, 2004 Indonesian tsunami. All of these images are available and used throughout the SOS network.

Based on earlier finding from the baseline study, for the second kiosk, the text was designed to include both description of the color representations and the method and time of data collection for each image. The tsunami text also included questions for the visitor, designed to increase their engagement through talking about and potentially extending the content. Two of the questions were open-ended, and one was answered in the text. All of the sections except El Niño featured more than one slide of text on the kiosk and an arrow at the right-hand side of the kiosk to move to the next slide. Two of four moves forward cued up the next globe image, while two simply continued the text associated with the current globe image. Each secondary slide also contained an arrow indicating visitors could go back to the previous slide. All slides contained two options in the lower-right, indicated by icons:

a house icon to allow the visitors to exit the kiosk completely to the “Touch to begin” attractor screen and an “X” icon which would take the visitors back to the menu of four topics.

In addition all new text was narrated, and narration played automatically for visitors upon choosing a topic or advancing to the next kiosk slide. No option to replay or pause the narration except by advancing or reversing the kiosk in the middle of the narration was available. The narration of the longest slide was approximately forty-five seconds. Viewing of the entire set of four topics including all slides in each topic required approximately seven minutes, almost twice the average time spent at the exhibit in the baseline and first formative evaluation.

Kiosk Navigation and Use:

The original kiosk often led to many topics selected in a very short time period. Few images were viewed in-depth, as evidenced by either continual flipping of the poles back and forth rapidly, or rapid selection of subsequent images, with a dwell time on the images of only a few seconds to a maximum of thirty seconds. For the old version, only 31% of visitors viewed images in all available groups. The new kiosk encouraged visitors to use more of the storylines: 90% of groups viewed all four of the topics. No group exited a topic before the narration finished for the kiosk, or failed to go through all the slides/images within any of the topics.

Visitors did mention problems seeing some of the imagery on the globe, either due to position of the image on the globe, the kiosk screen blocking their view, or the height of the globe. When stools at the kiosk were replaced with chairs and the images were rotated to bring areas of interest to the front, these complaints disappeared from further observations and video. When chairs were removed entirely, more visitors were encouraged to move around the globe (taking advantage of the fact that it is a sphere).

Lighting and visibility continued to be a problem through all stages of evaluation. All of these concerns were addressed through manipulations of images except for the poor lighting. This has been a constant source of frustration for both visitors and



staff. The probably only real solution is to invest in a new, higher powered projector.

Visitor interaction with text and images:

In the original kiosk setup, 40% of visitors spent little time on interacting in any depth with the Magic Planet. Groups often went superficially through many of the images, with an average of 9.68 images chosen per group out of a possible 17. With an average total interaction time of nearly five minutes per group, they spent about 30 seconds per image. Additionally, 38% of groups spent an average of fewer than twenty-five seconds on any given image, and 20% spent fewer than fifteen seconds average on each image.

In the original kiosk, 46% of the groups were observed reading aloud, and half of these read aloud only once, indicating that many of the groups may not have made use of the text. In addition, the unobtrusive observations condition offered a section on Solar System images which was popular with visitors, indicating that time spent on Earth system images might have been even lower than average. For example, several groups looked exclusively at solar system images, though these groups had low dwell times overall. One group started out and went through all the solar system images, and then went on to a few of the Earth science images, but spent less than 10 seconds on any of the Earth science images.

For the new kiosk, reading aloud disappeared as a category, most likely because all text was narrated. 92% of visitors to the new kiosk interacted with images from all four storylines for an average interaction time of just under 7 minutes. Visitors using the new kiosk spent longer on average with each globe storyline (which included more than one globe image except in the case of El Niño) than users of the individual images in the original kiosk. For the new kiosk, users ranged from an average of just over a minute and a half per storyline to over two minutes. Even considering that most of the new kiosk storylines had more than one image each, this represents quite an increase from the previous average of 30 seconds per image in the original kiosk. Time viewing images seems to have been dictated often simply

by the length of time it took for the narrator to complete the narration, whereas the original kiosk dwell time was completely user-driven.

Visitor Interactions with each other

In the original kiosk, groups were fairly split on the presence or absence of interactions or discourse that suggested they were working together. 56% of the groups using the original kiosk made statements directing one another or asking for another group member's opinion on which images to view. The new kiosk design supported visitor more interactions. For the new kiosk, most groups did work together to decide the order of content to view; at least one group member consulted or directed another in all 100% of groups.

Of the four new kiosk storylines, the one that provoked the most visitor-visitor interactions per group was Coral Bleaching, with 16.6 interactions per group. This was also the longest storyline with three separate slides of text, requiring about 2.5 minutes to view the whole set. All others sparked about half as many average visitor-visitor interactions per group. The individual slide provoking the most visitor-visitor interaction was the Human Impact slide of the Coral storyline, with 10 interactions average per group. This is also the slide that was most difficult for most visitors to make sense of in stimulated recall. In fact, when viewing the video and reflecting on it, many visitors had difficulty recognizing the image and remembering what it was about – even though it generated the most talk among visitors while viewing.

66% of visitor-visitor interactions included discussion around the content either in the form of statements or questions that included content from the images or text. 71% of the content statements and 50% of content questions were “meaning-based,” where visitors made statements about the meaning of the content. Clarification questions or statements that repeated or sought to clarify text or locate items in the image made up the other 29% of content statements and 50% of content questions.

Groups working with the second kiosk also used various forms of deixis as they interacted with the



globe, indicating they were having conversations with at least presumed shared meaning, or in which they were trying to create shared meaning. Deictics are words and gestures that “point out” ideas or things in the immediate physical or discursive context. Common deictic terms include “this”, “that”, “those”, “there”, “here”, and common deictic gestures include pointing. Deixis is a common feature of communication where interlocutors assume intersubjectivity (Rommetviet, 1974), and are very common in talk where there is a shared focus of attention such as looking at an exhibit together (c.f., Wertsch, 1989; Linell, 1998, Rowe, 2002).

In the case of the videotaped observations, the most commonly used deictics referred to or point out places in the visualizations or referred to previous parts of the group’s discourse. The most common referents of the discursive deictics were parts of the groups’ earlier conversations that had included content from the kiosk text and narration. Often these were accompanied by pointing either to the globe or the screen. A new code for the video observations, “LookSee,” also indicated the use of place deixis as visitors asked other group members if they could see particular features, and these were often accompanied by pointing. In total, 80% of groups used deictics to point features out to other group members (LookSee – place deixis), including 60% that also used discourse deixis.

Information on discursive deictics was not collected for the first kiosk, as such analysis requires audio or video taping and transcription. However, pointing and other physical deictics were employed by only 36% of groups in the earlier kiosk version. This change in the use of deictics suggests that the second kiosk supports visitor interaction and group meaning making in ways not supported by the original version.

Information Transfer

Every text has two functions, to transmit information accurately and to help generate meaning (Lotman, 1974). We can extend this notion to texts and objects in informal learning environments (Rowe, 2002). From this point of view, we are interested in whether an exhibit with its combination of

text, interaction, and imagery is conveying information adequately (i.e., in terms of basic information about the images, such as dates of occurrence, color as it conveys data, and types of data sources used) and supporting visitors in making meaning of the exhibit for themselves (i.e., in terms of connections visitors make to other images on the kiosk or to other experiences or knowledge beyond the exhibit). In our redesign, the text in the new kiosk, especially, was geared toward not only providing information, but also context that could be used to make connections. For example, the globe images themselves can convey basic information such as a hurricane’s path but also help to generate connections, such as “the shape of the clouds is why they call it an eye,” when a visitor saw a swirling hurricane on the globe and connected it to a symbol on a weather map.

Data on information transfer was not collected for unobtrusive observations, but was a portion of the stimulated recall interview for the second version. For the new kiosk, information about the time of data collection for the images was poorly transmitted, especially for the hurricane and tsunami images, but also for the corals. For example, one adult male thought that the hurricane and tsunami images were from 2009 when in fact they are from 2005 (Katrina) and 2004 (Ivan). In another group, group members confounded several of the timelines from different storylines; when asked when the El Niño images were from, one adult thought it was 2004, but another disagreed saying that was hurricanes or tsunami. One child reported that she thought that “most of” the images were from August 2004, when asked whether she could remember when any of the images were from. Other groups simply did not remember. Groups also either could not recall when the tsunami occurred, or also thought it happened more recently than five years ago. Finally, only 20% of groups asked could explain that the coral bleaching image was current or recently updated. The fact that the world is currently experiencing an El Niño, however, was recalled by a majority of groups. One participant who considered himself “into” geography was surprised that the dates did not register for him.



The data source for the images was somewhat better understood. Many groups recognized the source of satellite images, though it was unclear in the reflections whether this was a guess in some cases or whether they learned it from the text. It was harder to gauge visitor understanding of the source of the tsunami data (the kiosk text says “satellites and buoys”). Visitors described it as “meters in the ocean” or “something similar” but could not name them, and no groups volunteered that the data was from a different source than the other images. It may be that they were assumed to be from satellites as well.

However, the narration and text did transmit some information. Most groups were able to talk about information that was new to them from the text during stimulated recall (e.g., “I didn’t know El Niño was an every (sic) year thing,” “hurricanes come from Africa,” “Katrina weakened,” “We’re in El Niño now,” “the [waves from the Indian Ocean tsunami] spread so far,” “there aren’t any cold-water corals,” “I didn’t realize all of those things affected corals”).

As for color comprehension, two images caused significant confusion: the second image of the hurricane sequence, which included sea surface temperatures in order to explain hurricane formation, and human impact on corals, where reds and blues were sometimes confused with water temperatures. The tsunami image text also mentioned yellow for the highest waves, but these waves occurred only very near the original earthquake, so often visitors missed seeing them, as the animation starts playing immediately upon selecting tsunami from the menu.

Meaning Generation

Much of the talk at the exhibit in both kiosk versions was simply Exclamations. Such talk offers evidence that visitors are surprised or engaged, but little evidence of visitors working collaboratively to make meaning around the content of the exhibit, either the text or the images. 72% of groups interacting with the original kiosk exhibited exclamations or statements of interest, with an average of 3.92 such surface interactions per group exhibit-

ing them. There was no change with the change in kiosks. For the updated kiosk, 73% used these low-level interactions, at a rate of 5.75 exclamations or “interesting” statements per group that used them. The larger number most likely is an artifact of the longer stay time. For most groups in both cases such exclamations made up the bulk of their talk at the exhibit.

An intermediate level of interaction was represented by talk for Identifying places. These represent some connection to prior knowledge and experience, and in some cases during reflection groups pointed to identifications that they did as part of “orienting” themselves within an image. This orientation may be an important aspect of meaning making. In the original kiosk, 50% of groups employed these intermediate level identifications. 60% of groups employed them in the second version. For the original kiosk, groups used an average of 2.8 identifications each versus 3.6 for the newer kiosk. While these changes are very small and certainly not significantly different, the second version does seem to support more intermediate level interactions aimed at meaning making.

Several codes were used to indicate deeper interactions or more engagement with the text and images. These were making a Content Statement, making a connection to Prior Knowledge or Prior Experience, Offering an Explanation, Making an Extension to another content area, and Making a Hypothesis.

For the first version of the kiosk, 75% used any of these types of interactions, though they were almost exclusively content statements. In fact, 89% of the groups that exhibited deeper interactions made content statements, using an average of 2.5 content statements per group. 47% of the total used an additional type of deeper interaction than a content statement. 65% of those groups made explicit connections to Prior Knowledge, and 82% asked content questions. Only 2.5% of that group made a hypothesis.

The new kiosk showed a small change to 80% of groups using some sort of deep interactions, but the number of interactions per groups increased



dramatically over the original kiosk to 13.1 per group. The variety also increased, with 80% of those groups using a second or third type of deep interaction beyond Content Statements. 60% made explicit connections to prior knowledge and 67% asked content questions. The new version was no better at supporting visitor generation of hypotheses; no groups in the second version made any. In the end, then a total of 36% of visitors to the first version and 64% of visitors to the second version engaged in some sort of discussion around content beyond simply making a statement about it. The second version of the kiosk was therefore only slightly better at getting visitors to talk about content, but it did create conditions for more visitors to engage in more talk that attempted to make meaning out of that content.

Making connections across storylines and images

Visitors were able to connect the images in a given storyline and across storylines in their reflection, but they also often conflated information that they learned from one part of the story with another image. For example, when discussing the hurricanes, visitors sometimes recalled names such as Ivan and Jeanne, hurricanes from the 2004 season and the second animation in the storyline of the new kiosk, when watching themselves viewing and discussing the first animation in the sequence, the 2005 season. This connection could be an indication of making deeper meaning across the images if visitors recall that Katrina did not form off of Africa as Ivan and Jeanne and many other Atlantic hurricanes do. On the other hand, it is likely that visitors are simply conflating information from different storylines, such as confusing El Niño colors, which indicate temperature anomalies, with the tsunami colors, which indicate wave height. It is probable, as mentioned in the recommendations, that remediating the images themselves and addressing lighting concerns could address this confusion. It is also likely that making connections between images and storylines explicitly in the narratives might support visitors' own connection making as they do listen to and remember aspects of the narratives.

Moving around the globe and making connections

As part of reflection and stimulated recall, visitors expressed that the globe did help them understand the imagery in ways that flat maps could not. This might be due to the wrapping effect of seeing something move across the globe. As one visitor put it “particularly with tsunami aspects and hurricane aspects, you get a better sense of the movement.” It might also have to do with seeing the part in relation to the whole: “the scope of it ... makes it seem more real, that it goes around the globe as the globe is moving.” It might further help underscore the “real” nature of the data and visualizations. As another visitor put it, “with flat maps ... it’s not really the same as on a round map, where things really are.”

However, the new kiosk, and especially the positioning of the images on the globe to be right in front of the kiosk, discouraged visitors from walking around and using the full 360-degree experience of the content that the globe can offer. Only the first two videotaped groups walked around the globe at all. These were the only two groups that did not have the regions of interest placed directly in front of them on the globe. Few visitors, therefore, are making use of the spherical nature of the exhibit. During the course of videotaping, stools at the front of the Magic Planet were replaced by chairs (2” taller) to address sightline issues. These chairs were eventually also removed, and there is some evidence in videotaping that with no places to sit, visitor groups tend to arrange themselves around the Magic Planet and move around it more often. There is very slight evidence that this may also encourage multiple members of groups to operate the touch screen. When visitors were seated, one person usually operated the touch screen, sometimes asking for input from other members of the group. When chairs were removed, more individuals within groups operated the touch screen.

The focus “imposed” by the seating and the context of the research project also were cited as reasons for not walking around in the stimulated recall interviews (“I thought [the part I wanted to see on the globe] would come around again,” and “I



was supposed to sit down and do a survey”). This is similar to findings at the Science Museum of Minnesota in July 2006, where 60% of visitors sat down to watch Science on a Sphere programs, and 17% of visitors suggested more seating to improve their experience (Nelson, 2006).

Building on prior knowledge and experience

In video reflections, visitors cited connections to their own prior experiences as the key driver of interest in particular images or storylines. Visitors also reported learning new information such as coral locations, how earthquakes make tsunamis, that the East and West Coast of the U.S. had been “affected” by the Indonesian tsunami, and that hurricanes start off Africa. Information overload on some topics were also cited for lack of interest in certain images or storylines (“For me, El Niño is overdone”, “I already knew how [hurricanes] were made”). Only one group mentioned their interest in the connections of the stories to the local Oregon area, such as the tsunami connection and the El Niño connection.

The second kiosk afforded more connections to prior knowledge and experience. For the original kiosk, 28% of groups made statements that included prior knowledge, and 12% used prior experience. For the newer kiosk, this number more than doubled to 60% of groups using prior knowledge. Only 6.6% invoked their own prior experience, however. Video stimulated reflections generated a few more groups citing personal experience as reasons for interest in particular topics. For example, one member of the Oregon National Guard had been called to help with Hurricane Katrina relief, and one visitor had spent time volunteering after the tsunami.

One group explained in the interview their confusion about the text due to its conflict with prior knowledge and experience. In trying to understand the effects of El Niño on their region of the country, Northern California, where they had heard recent weather reports describing the effects of El Niño on their area as bringing more rain. During the interviews, other groups mentioned information that was new to them, such as that hurricanes form off of Africa, that there are few cold-water corals,

that ocean temperatures varied “that widely” (and affected corals), suggesting that they considered their current banks of knowledge when listening to the narration and looking at the globe without making them explicit to each other. Thus, while many groups did not make explicit references to prior experience in their talk, it could be that more groups made use of prior experience than is evident in their discussions. The video-stimulated reflections are a good chance to uncover the connections to prior experience that may be important elements of visitor meaning making otherwise invisible to the observer.

Discussion

The use of a kiosk does invite user exploration of the globe. One of the interviewed groups mentioned having visited before when there was no kiosk at all and being confused as to what to do, finding this more recent visit much more satisfying and understandable use of the Magic Planet. However, kiosk design is important in providing support for visitor information transfer, meaning making and interaction.

Generally, the use of a kiosk produces similar or longer visitor dwell times with the Magic Planet compared with the playlist-only version of Science on a Sphere evaluated at the Science Museum of Minnesota. Our original kiosk produced a median dwell time of 3 minutes, 30 seconds in unobtrusive observations, and our new kiosk produced a median dwell time 6 minutes, 53 seconds in videotaped observations. Visitors report not only enjoyment but also increased understanding of the stories presented on the globe and believe the spherical display helps them to understand Earth’s processes better. This understanding is supported by their responses in interviews to stimulated recall questions. Visitors are using the kiosk and globe to make shared meaning, evidenced by seventy percent of groups using place deictics to ensure other group members see what is referred to in the narration, as well as evidenced by the use of deeper-level statements and questions to make meaning beyond simply clarifying. Deeper meaning making is also supported by making connections to prior knowl-



edge and experience, and the newer version of the kiosk does support this kind of meaning making as well. In addition to changes to improve the rates of this meaning-making, what remains to be worked on is the connections to the science in the images as “current,” changing, and relevant to visitors’ lives.

Overall, the newer kiosk seems to be effective at engaging users and supporting their interactions with the images and with each other. It is much better than the original or first designs of the kiosk at supporting visitor meaning making and connection making, but not much better at transferring detailed information about the images on the globe to them. Relatively minor adjustments to image positioning and halting rotation made it much easier for visitors to locate on the globe the regions of interest highlighted in the kiosk text.

However, one trade-off for easily recognizable areas of interest seems to be a decreased amount of walking around the globe that visitors do. In that case, is a full 360 degree globe necessary or would visitors be satisfied with a “half-globe” that offered the same sense of scale and three-dimensions that may be superior to a distorted flat-map image? More variations need to be studied including removing seating entirely from the kiosk area or updating text to explicitly encourage visitors to walk to the other side of the globe to see a different version of the same phenomenon (i.e. Pacific ocean basin typhoons) to determine whether visitors will make more meaning from a 360-degree experience.

In addition, the focus of the text on delivering information may have reduced the amount of meaning-making by groups as a unit. For example, the first group actually missed opportunities to discuss the information with the youngest visitor, who made several observations about the colors on the globe:

“It does not look like there’s any land”

(looking at Indian Ocean basin on Hurricane Ivan image).

“It’s aaaaallllll white ... there’s not much blue, not much water. It must be the desert or something”
(when in fact, she was looking at the ocean represented as white on the coral bleaching image).

However, the adults did not address any of these comments at all to clarify, and only once to repeat “Not many blue areas.” Another adult pair who indicated that the male was high-knowledge and often taught the female had little discussion despite many questions she posed while looking at the images. Revisions to kiosk text that offer questions for visitors to answer by directing them to look at specific features of the imagery and encouraging them to make comparisons, coupled with opportunities to pause the narration, may increase the dialogue.

Recommendations

Getting volunteers and staff using the globe:

In-depth volunteer training and support is necessary for volunteers to begin using the Magic Planet in interpretation. An alternative is to work with undergraduate interns and graduate students in courses at OSU (COSIA course, HHMI Science Connections course) to create interpretive scripts, programs, and interactives. This requires having 1) a basic training available to them, 2) graphics and content support, and 3) an easy to use production interface.

Attracting More Visitors into the exhibit area:

Vinyl flooring marks and temporary barriers have increased the number of visitors entering the room by about 10%. Still only about 1/3 of visitors enter the room at all. Regularly scheduled programming (i.e., staff presentations using the globe) might bring more people in. Removal of the doors was also suggested in interviews with staff as a way to create a more “inviting” atmosphere. Lastly, a brighter globe (i.e., higher powered projector) might make a more striking lure for visitors.

Attracting More Visitors to use the Magic Planet:

It seems clear that the installation of the 42” flat-screen monitor mirroring or complementing content on the Magic Planet. When it was operational only mirroring touch screen content use jumped from 50% of people entering the room to 85%. The primary hurdle to keeping the second screen opera-



tional was that the Shuttle computer included with the Magic Planet does not allow for a third monitor. This should be easily taken care of with a computer upgrade.

Lighting:

Even in low light conditions, images on the Magic Planet are not bright enough, something constantly noted by both staff and visitors. Details of complex visualizations, especially of false-color data sets are extremely difficult to make out. It is not clear that the room can be made darker, nor that this would address the issue in a way that doesn't render all other exhibits in the room unusable. New bulbs in the current projector help this situation temporarily, but for only a few weeks. The most probable solution is to invest in a high-powered projector that would double or triple the lumens of the current projector.

Narration:

Narration was an asked-for feature in previous work with SOS and Magic Planet. It also substantially increased average time spent viewing individual images. However, there is some concern that the narration itself may constrain visitor control, choice, and meaning making by privileging one particular way of using the Magic Planet. One solution is to make it possible for visitors to toggle the narration on and off.

The narration may also be able to support more moving around the globe and making connections across images and storylines. Cues to visitors to move around the Magic Planet to see or find certain things and modeling of making connections within the narration might support visitors' own connection making and use of the full 360 degrees of the sphere.

Information Transfer

Images themselves transmit basic information such as dates of collection, method of collection, meanings of colors, etc. very poorly. Visitors do, however, recall information from the text and narration when it is new to them. It may be that information about how and when the images were

collected is not salient to visitors as an element of making sense of the image. This is consistent with findings from previous work at the VC (Phipps and Rowe, 2010) and at Maryland Science Center (Barthel, 2010) suggesting that visitors need direct instruction on how and why these may be important in making sense of false color earth systems visualizations. Where possible dates, scale bars, and meanings of colors should be included on images themselves, and text should prompt visitors on what to focus on and see in images.

References

Barthel, C. (2010). Understanding Visitor Interactions with Complex Visualizations on Spherical Display Systems in Informal Learning Environments. Unpublished Master's Degree Report, Corvallis, OR: Oregon State University.

Falk, J. & Dierking, L. (1992). The museum experience. Whalesback Books, Washington, DC.

Linnell, P. (1998). Approaching Dialogue: Talk, Interaction, and Contexts in Dialogical Perspective. London: John Benjamins.

Nelson, A. (2006). Science on a Sphere: Formative evaluation report. Science Museum of Minnesota's Department of Evaluation and Research in Learning.

Phipps, M., and Rowe, S. (2010). Seeing satellite data. *Public Understanding of Science*(19)3: 311-321.

Rommetviet, R. (1974). On message structure: A framework for the study of language and communication. London: Wiley

Rowe, S. (2002). The role of objects in active, distributed meaning-making. In S. G. Paris (Ed.), *Perspectives on object-centered learning in museums* (pp. 17-32). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Rowe, S., Barthel, C., Stofer, K., & Hunter, N. (2010). Promoting Meaning Making at Spherical Display Systems: Evaluation Toolkit. Corvallis, OR: Oregon Sea Grant.

Stevens, R., & Hall, R. (1997). Seeing Tornado: How Video Traces mediate visitor understandings of (natural?) phenomena in a science museum. *Science Education*, 81, 735-747.

Stevens, R., & Toro-Martell, S. (2003). Leaving a trace: Supporting museum visitor interaction and interpretation with digital media annotation systems. *Journal of Museum Education*, 28(2), 25-31.

Wertsch, J. (1998). *Mind as Action*. Cambridge: Cambridge University Press.

