Secrets of Circles
Summative Evaluation Report

Prepared for the Children's Discovery Museum of San Jose

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Executive Summary

This report describes a summative evaluation of *Secrets of Circles,* a 2,600 square-foot exhibition (modifiable to 2,000 square-feet) created by the Children's Discovery Museum of San Jose (CDM), and funded by the National Science Foundation. The exhibition and related programs were designed to highlight the uses of circles and wheels in everyday life. Circles have properties that make them extremely effective as an engineering tool, and they are ubiquitous in cultures around the world.

> "The properties of circles determine why they're all around us. Every circle has a secret, that is, a reason for being a circle."

The summative evaluation was conducted by Allen & Associates to determine the impact of the exhibition and a few of its related materials, in terms of:
- attracting children aged 3-10 and their care-givers,
- engaging them in math/science activities,
- communicating the special role of circles in science and culture, and
- welcoming families of Mexican and Vietnamese descent.

Finally, the exhibition traveled to two remote sites, and its impact there was assessed through in-depth interviews with staff.

Data was collected between November 2006 and January 2007, except the interviews with staff at the remote museums, which took place in August and September 2007, once the exhibition had begun to travel.

Principal Findings: Tracking and Timing Study

Participants
- During the tracking and timing study, 113 visitors were unobtrusively observed using the exhibition during weekends or holidays.
- Equal numbers of three age groups were tracked, to facilitate comparisons: younger children (3-5 year olds), older children (6-10 year olds), and adults.

Use of exhibition
- Visitors spent a median of 14.6 minutes in the exhibition, significantly longer than exhibitions of similar size.
- Visitors of different ages, group sizes, genders, and prior experience with the exhibition all spent similar amounts of time, showing a broad spectrum of extended engagement.
- Visitors stopped at a median of 11 elements (44% of available elements), which is significantly more than the reported average for museum exhibitions.
- Visitors used the entire gallery, and tended to move from one interactive exhibit to another one nearby.

Outstanding individual exhibits

- Three elements stopped over 70% of visitors: Ripple Table, Inventing the Wheel, and Compass Table.
- Four elements sustained visitors for more than 90 seconds: Circle Videos, Spin Pictures, Compass Table, and a centrally located bench.
- Two elements engaged visitors for longer times on repeat visits to the exhibition than first visits: the Round Boat in Circles in the World, and Circle Videos.

Frequent visitor behaviors

- Levels of physical interactivity (where possible) were high: 84% overall, and 91% for children.
- Visitors tended to use the exhibition in groups rather than individually:
    - When stopping at exhibits, they were accompanied by someone else 79% of the time.
    - Most children talked to adults while at exhibits: 77% of younger children and 62% of older children.
    - Children often used exhibits physically while alongside, or taking turns with, adults (64% of younger children and 47% of older children).
    - Adults stayed at exhibits for as long as children; they did not sit back and disengage.

Differences

- Girls spent marginally longer than boys in the exhibition (19.0 mins versus 12.2 mins).
- Men stopped at more elements than women (11.5 versus 9.0).
- The round boat in Circles in the World engaged younger children for longer times than older children, mostly engaging in pretend play. It was also more attractive to girls than boys.

<u>Principal Findings: Interviews with Adults</u>

Participants

- 107 adults were interviewed as they left the exhibition. All were visiting with children on a weekend or holiday.

Overall responses

- Most adults were enthusiastic about the *Secrets of Circles* exhibition, appreciating the theme, the closed off gallery, the colorful and natural design, and the accessible interactive experiences.
- About one third offered suggestions for improvements: including more elements for younger children, more detailed explanations in labels, and even more interactive exhibits.
- Adults' favorite exhibits were Spin Pictures, Gears, Ripple Table, Circle Videos, and Compass Table.

Understanding of Circles theme

- Fully 85% of adults recognized that the theme of the exhibition was Circles. They talked about the properties of circles, their uses, ubiquity in daily life, how they can move or spin, and how to make them.
- Adults resonated most with the Circles Secrets that had to do with the usefulness of circles and their prominent role in daily life. Secrets that involved symmetry, smoothness, or

trajectories, were rarely articulated, though visitors did understand the implications of these notions, such as: a curved bridge is strong, or a spinning wheel runs smoothly.
• Labels played a key role in promoting understanding:
    - Visitors whose home language was English, Spanish, or Vietnamese were more likely to recognize the Circles theme than those whose home language was not in the labels.

Personal connections
• 61% of adults said they had made a connection to their own lives. Half of these were connections to specific objects (such as gears, bridges, or mirrors), and the other half were connections to broader ideas (such as how technology works, the circle of life, or memories of using compasses in school).

Responses to exhibition design
• About one third of the adults said they had noticed the colors of the exhibition, mostly commenting that they were pleasantly bright, with purples and greens.
• About one fifth of the adults said they had noticed the materials of the exhibition, particularly the wood and bamboo. Some described these as "natural."
• Adults liked the open layout, good traffic flow, quiet atmosphere, available seating, kid-friendly exhibit heights, and overall comfortable feel. Several noticed a circular theme to the materials, objects, and even the room.

Responses to the multilingual labels
• Visitors found the labels understandable and had very little difficulty using them.
• Almost two thirds (62%) noticed that the labels were multilingual and had a decidedly positive response.
• 86% said they would recommend that future exhibit labels be in other languages as well as English, and most of these people spoke English at home. A further 11% had no preference, and only 2% recommended English-only labels.
• Those visitors who spoke Spanish as their home language were especially supportive of the labels, with every person in the sample offering strongly positive comments.

<u>Principal Findings: Interviews with Children</u>

Participants
• 89 children aged 3-10 were interviewed as they left the exhibition.

Overall responses
• Children particularly valued the number and variety of activities the exhibition offered, as well as the chance to explore and learn about circles and other shapes.
• Children's favorite exhibits were Gears, Build an Arch, and Inventing the Wheel.
• About a third of the children identified something from their own lives that they were reminded of while using their favorite exhibit.

Understanding of Circles theme
• With the help of a sheet of photographs, two-thirds of the children could identify a circle in their favorite exhibit.

• About half of the children named mathematical or engineering properties (roundness, lack of corners, ability to spin or roll) as the best thing about a circle.

Principal Findings: Interviews with Vietnamese Families

Participants
• 8 Vietnamese families, and a Vietnamese community leader, were invited to CDM and interviewed in depth, during and after using the exhibition.
• Parents were first-generation Vietnamese, and most had not been to the museum before.

Overall responses
• Most adults responded very positively to the exhibition, seeing it as helping their children learn as well as have fun.
• One parent was concerned that the exhibits were fun rather than educational, especially for his 10-year old son.
• The community leader considered the exhibition deeply valuable, with its technological emphasis, connections to daily life, opportunities for children to engage in motor skills, build confidence, develop language skills, and the chance for parents to broaden their definitions of learning.

Response to Vietnamese aspects of exhibition
• Families varied widely in terms of how much they saw Vietnamese culture represented in the exhibition. Most recognized the round boat and talked about it, but some families saw nothing Vietnamese at all, while others named items that were intended to be generic (such as the lathe, compasses, pulley, and bumpy roads).
• Several first-generation parents were critical of the exhibition's inclusion of elements from other Asian cultures, especially the Chinese hats used in conjunction with the Vietnamese round boat. Most were concerned that the public would be misled about what constituted Vietnamese culture. By contrast, the community leader, who was second-generation Vietnamese, saw herself substantially reflected in the overall Asian theme of the exhibition.
• Families used the multilingual labels in a variety of ways, including: reading the Vietnamese text in order to understand the exhibit, reading it aloud to help another person, reading both English and Vietnamese versions in order to understand the exhibit better, practice language skills, or check the quality of the translation. Most were supportive of the labels and/or appreciative of the museum's attempts to include their community.

Perceived obstacles to museum visitation
• The families identified obstacles to greater visitation by members of the Vietnamese community: high admission fees, parking fees, distant location, poor physical visibility, and insufficient community awareness of the museum's existence due to a lack of advertising in Vietnamese media or connections with community-based institutions. They encouraged the museum to generate more public offerings that reflected Vietnamese traditions and culture (none of them had heard of CDM's previous programs or exhibitions in this regard).

Principal Findings: Interviews with Mexican-Descent Families during Special Event

Participants

- 16 adults and 14 children were interviewed during a special event, the Three Kings Celebration (Tres Reyes).
- The median group size was not significantly different from that of the regular weekend audience (4 people).

Overall responses

- Children's responses were indistinguishable from those of the regular weekend audience.
- Compared with the regular weekend audience, adults at the Three Kings Celebration were less likely to recognize the Circles theme, and less likely to notice the labels, but more positive about them when they did.

Principal Findings: *Secrets of Circles* Family Science Night

Participants

- Several hundred families, fifteen teachers and a handful of volunteers joined CDM staff for the *Secrets of Circles* Family Science Night at Dilworth Elementary School in San Jose.
- This school was a "best case" host for the event, with dedicated teachers, high parent involvement, strong community spirit, middle to upper socioeconomic neighborhood, and a history of high performance on standardized tests.

Overall responses

- The event ran very smoothly, with teachers quickly learning from CDM staff how to facilitate Circle-based activities at different 10 stations, using the well-designed materials and instructional sheets.
- Children from grades K-5 and their families participated with great enthusiasm.
- Interviews with children suggested that they were impressively adept at figuring out both what to do and what the mathematical or science-related principle behind each activity was.
- There was a good deal of productive mathematical and science-related conversation embedded in the joint activity that was loosely shared by children, parents, friends, and teachers.
- Teachers and parents valued the hands-on nature of the activities, the way children could explore materials that interested them and work at their own pace, and the opportunity to mix informally with the rest of the community.
- The circles theme was relevant to teachers' agendas and that the event provided them with ideas to enrich their own teaching in the future.

Principal Findings: Interviews with Staff at Two Museums Hosting Traveling Exhibition

Participants

- 10 staff members from two hosting institutions were interviewed: the Ecotarium in Worcester, MA, and Strong National Museum of Play in Rochester, NY.

Logistical aspects

- Staff at both sites said the exhibition was well made, and that the castors made installation easier. The custom-designed crates also helped, though they were difficult to store.
- There were challenges in getting spaces dark enough to display the exhibits with fluorescent displays, but these were resolved satisfactorily.
- There were significant maintenance needs, exacerbated by the exhibition's heavy use by a variety of audiences.
- A few exhibits raised safety concerns.

Audience engagement

- The staff noted high levels of visitor engagement, and thought visitors appreciated the aesthetics and the range of types of activity.
- Staff felt the exhibition worked for a broader range of ages than they had expected, and seemed to encourage collaboration between adults and children.
- Surprisingly, the Circles-related Theme Day had to be canceled due to lack of interest from schools.
- Ecotarium staff reported seeing many visitors using Spanish label text. Some visitors were puzzled by the Vietnamese text, until staff explained the exhibition's origins.

Staff responses

- Overall staff responses to the exhibition were positive.
- Staff at both sites used some of the materials that came with the exhibition, modified others to fit their needs, and were also inspired to create programs from scratch. Staff reported some frustrations related to the marketing materials.
- Staff saw the multilingual labels as adding value to the exhibition.
- Ecotarium staff used the exhibition to move forward on their program of outreach to their local Spanish-speaking community, by hosting a "Fiesta under the Moon" in collaboration with local organizations.

Discussion of Main Findings

In the later sections of this report, discussion about the detailed findings has mostly been interwoven with the findings themselves. However, the following were key questions the team asked at the beginning of the summative evaluation process, with answers as best determined by interpretation of the full set of data collected.

1) How did visitors use the *Secrets of Circles* exhibition?

The overall usage of the exhibition by visitors was impressive: they spent a long time in the gallery, and most of the time was spent actively engaged with exhibits. The median time spent in the gallery was 14.6 minutes, and the average was 17.4 minutes, over 50% longer than Serrell's model predicts based on gallery size. In other words, visitors stayed far longer than adults visiting comparably-sized exhibitions at other museums.[1]

Furthermore, visitors spent the great majority of this time actively attending to exhibit elements, rather than sitting on benches or socializing away from exhibits. Researchers studying the Sharks exhibition at Monterey Bay Aquarium found equally high levels of percentage time attending[2]; in fact, their figure exactly matches the *Secrets of Circles* figure for adults, and only adults were tracked in the Sharks study. The great majority of tracking and timing studies target only adults, so perhaps this study serves as a baseline finding that, at 87%, the percent time attending was even higher for children aged 3-10 than for adults.

Also impressive is the number of elements visitors used. Overall, 42% of visitors stopped at more than half of the elements in the exhibition (counting the large-format signs/banners as elements but not the benches). This number, which Serrell calls "%DV (the percentage of diligent visitors)"compares very well with 24%, the median for exhibitions in the museum field. Overall, then, visitors spent a long time in the exhibition and used it quite thoroughly.

It is impossible to know for certain which factors contributed to the long holding times and high diligence of visitors using the exhibition. Here we speculate about several possible influences:

- The exhibition itself had been thoughtfully designed and extensively prototyped, with a range of exhibit genres, and many elements that deeply engaged a majority of the audience. Evidence for this came not just from the tracking and timing study, but also from interviews with adults and children.
- During the evaluation, the exhibition was housed in a gallery that was entirely enclosed, with a single entrance / exit; this may have contributed to visitors' holding times by

[1] Serrell, B. (1998). Paying attention: Visitors and museum exhibitions. Washington, DC: American Association of Museums. For more details of Serrell's method and findings, see the earlier section of this report on the tracking and timing study findings.

[2] Yalowitz, S. & Ferguson, A. (2006). *Sharks: Myth and mystery*: Summative evaluation. On-line report at http://www.informalscience.org/evaluation/report_list.php

reducing the distractions of surrounding exhibits[3]. Several adults commented on their appreciation of the enclosed space, where children could spend more time with less distraction.

- The exhibition was studied at a children's museum, and the tracking included a majority of children. This is a major difference from Serrell's analysis, which included no exhibitions at children's museums, nor were any of the people tracked younger than 16. It is unclear how this might have affected the data: One might expect children to have longer holding times than adults (in cases where they want to repeat a particularly engaging activity), or shorter (reflecting a shorter attention span) or the same (because families tend to move together in groups). A large survey of children's behavior in museums is not currently available.

Movement maps revealed the following aspects of visitor movement through the gallery:

(i) The whole room was used by visitors; there were no large dead spaces.
(ii) Far more people stopped at interactive exhibits than at the signs or benches.
(iii) Visitors tended to go toward an interactive exhibit that was closes to the one they were currently using.
(iv) Almost every path from one exhibit to another was traversed by at least one person, suggesting that visitors were making active choices about where to go next.

Overall, this reinforces an image of a thoroughly-used space with many engaging elements, in which visitors followed non-linear paths of exploration.

Two classes of behaviors were very common: Firstly, visitors interacted physically with 84% of the elements that supported it. The rates for children were extremely high (91%), but even adults interacted at 70% of the interactive exhibits where they stopped, indicating they were participating actively as well as observing their children. Secondly, visitors tended to use the exhibition in social groups rather than individually. For example, when stopping at exhibition elements, they were accompanied 79% of the time. Children used exhibits physically while alongside (or taking turn with) adults in most cases: 64% for younger children and 47% for older children. They also talked with adults while at exhibits in the majority of cases: 77% for younger children and 62% for older children. High levels of social use by families is typical of exhibitions of all kinds. However, staff at children's museums sometimes complain that parents tend to sit on benches and let their children explore on their own.[4] This was not the case in *Secrets of Circles;* parents kept up with their children as they explored the exhibition, and interacted with them most of the time.

Family of Circles was the only element with significantly different engagement times between adults and children: Adults engaged with this exhibit for a median of 23.0 seconds, while the

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[3] Allen described a study where surrounding an exhibition with high walls increased holding times but decreased attraction. [Allen, S. (2004). Designs for learning: Studying science museum exhibits that do more than entertain. *Science Education, 88*(Suppl. 1), S17-S33.]

[4] A study of views of learning by parents and educators at a science-focused interactive exhibition in a children's museum can be found in Schauble et.al. (2002. Supporting science learning in museums. In G.Leinhardt, K. Crowley, & K. Knutson (Eds.) Learning Conversations in Museums (pp. 425-452). Mahwah, NJ: Erlbaum.

median for children was 32.0 seconds. Perhaps what is more interesting than this difference is that fact that it was so rare: for most elements there were no significant differences between the holding times for adults and children; adults were stopped at the elements of the exhibition essentially the same durations as the children they accompanied. They were not sitting back and disengaging from their children's activity.

2) Were some elements particularly successful?

Different elements of the exhibition had different strengths.

Attraction
The interactive exhibits were the most attractive to visitors of all ages; few people used the less interactive Book Bench, large-format signs (banners), or benches. Among the interactive exhibits, the elements that were most attractive to visitors were Ripple Table, Inventing the Wheel, Compass Table, Spin Pictures, and Round and Round. Each of these attracted at least 70% of visitors to stop there. These exhibits shared many of the characteristics of successful family learning exhibits that were identified by researchers Borun & Dritsas[5]: multi-sided, multi-user, accessible, multi-outcome, multi-modal, readable, and relevant.

Holding power
In terms of sustaining engagement, the element with the longest holding time was a bench, B4, which was situated centrally in the gallery and afforded a good view of the activities in the rest of the room. (However, this was only used by 6 people out of 113). Other than this bench, three elements held visitors for longer than 90 seconds (median time). They were: Circle Videos, Spin Pictures, and Compass Table. All three were interactive exhibits that offered some range of interaction possibilities, as well as unusual ways of seeing or representing circles.

Multi-visit engagement
Finally, two elements seemed to support increasing engagements over multiple visits. Specifically, Circles Videos and the round boat in Circles in the World both engaged visitors who were on repeat visits to the exhibition for longer times than they engaged visitors on their first visit. This may, of course, be due to a selection effect, insofar as visitors who attend the museum many times may be more likely to stay longer at exhibits in general, due to increased interest or lack of pressure to see everything at once. Nevertheless, these elements stood out as the only two in the exhibition with significantly longer engagements of repeat exhibit-visitors than first-timers.

Favorite
When asked what they had particularly enjoyed, many adults and children named specific exhibits in the exhibition. The favorite among adults was Spin Pictures, followed by Gears, Ripple Table, Circle Videos, and Compass Table.

[5] Borun, M. & Dritsas, J. (1997). Developing family-friendly exhibits. Curator, 40(3), 178-196.

Quality of parent-child conversations
A detailed analysis of the conversations among families was beyond the scope of this study. However, developmental psychologist Maureen Callanan and her research colleagues studied many of the exhibits from this perspective, and are in the process of analyzing and disseminating their findings separately.

3) Did visitors learn anything from the mathematical theme of the exhibition?

While pre- and post-tests of scientific or mathematical knowledge were beyond the scope of this evaluation, there were several strands of evidence that suggest children and their caregivers learned something of the STEM-related aspects of the exhibition. Specifically:

(i) Visitors of all ages engaged deeply with the circles-related exhibits.

Throughout the Circles gallery, children aged 3-10 and their care-givers were engaged for extended periods with circles-related phenomena and materials: observing, creating, refining, and using circular shapes in collaborative activity. This constitutes a form of scientific activity in relation to the topic: experimenting with a variety of circular and non-circular shapes embodied in the physical world.

(ii) Most adults understood the Circles-related theme of the exhibition.

It is a significant achievement to create an interactive exhibition in which a geometrical abstraction is not just parroted back, but generated from the individual experiences the exhibition offers. *Secrets of Circles* had an unusually clear theme, recognized by 85% of the adults interviewed. Commonly mentioned sub-themes were: how circles can be useful (20%), their ubiquitous presence in daily life (12%), the way they move or spin (11%), their properties (9%), and how to make them (7%). A small number of adults identified non-circles themes (such as an Asian theme, or lights, or culture), these too had relevance to the project team's intentions. Only 11% of adults did not recognize any theme in the exhibition, and nobody suggested a theme that was entirely off-topic from the project team's intentions.

This number may be high in part because only adults were asked to identify the theme, compared with exhibition evaluations in which older children are included in the interview sample. The question was considered too conceptually challenging for the younger children who were a key part of the target audience, and also the data collectors found that the phrase "while you were in the Circles Room" was a useful way to frame children's experience at the beginning of the interview as being limited to that particular exhibition. Nevertheless, it indicates success in terms of reaching the care-giving audience with the exhibition's main idea(s).

(iii) Children could identify circles in the exhibits, and many could talk about their geometrical and engineering properties in ways that were consonant with the exhibition.

Although children had been primed with the idea that they were in a room about Circles, they did show evidence of internalizing this idea. With the help of a photo-sheet of exhibits, 87% said there was a circle in their favorite exhibit, and 64% could follow up by identifying such a circle. Also, more than half of the children seemed to grasp the engineering and mathematical value of circles that were highlighted in the exhibition: When asked what the best thing about a circle is, 26% named geometrical properties (such as roundness, lack of edges, etc.) and a further 26% talked about engineering properties (such as spinning or rolling, or helping things move). Finally, many older children said they had enjoyed the chance to explore circles, or the fact that they had learned something.

(iv) Most adults could identify a physical exhibit with a functional circle in it, though they were not as facile at explaining the relationship between form and function.

Impressively, most adults (70%) could identify an exhibit with a functional circle in it, and almost every interactive exhibit was mentioned at least once. However, adults had a much more difficult time explaining how the circular shape helped. Only 21% of visitors gave some kind of explanation, and even these tended toward the descriptive or tautological (e.g., "it needed to be a circle in order to spin.") It seems that the exhibit provided engaging experiences in which adults recognized that circles played a vital role, but they lacked ways of stating how the geometrical properties of the circles allowed them to function so well (e.g., explaining that the car ride is smoother with circular wheels because the edge of a spinning circle is always the same distance from its center). The exhibition did not emphasize vocabulary, but it did emphasize how the properties of circles affect their function, and while visitors seemed to resonate with this, they were not able to articulate the connection using concepts such as smoothness, constant radius, or symmetry.

Articulating the relationship between form and function is not easy, and probably beyond the age-range that this exhibition targeted. It seems likely that the exhibition could have laid a valuable experiential basis for children (and even adults) to build later skills of causal reasoning and mathematical expression if they wished to. Such delayed outcomes are notoriously difficult to assess. The fact that both adults and children could readily identify circles as important functional components of the exhibits was a notable feat in itself, proving that the exhibition successfully embedded circles in the concrete world in such a way that they could be played with and also recognized as mathematical objects. Such insights are foundational to engineering and science.

(v) *Visitors of all ages made personal connections to Circles-related objects and ideas.*

Both adults and children were quick to articulate in their own words the Circles Secrets that were less focused on engineering: that circles are everywhere in our lives, that they are found in nature, and that they are useful shapes. Visitors also made personal connections between the objects in the exhibition and familiar things, both present and past, both concrete and metaphoric. Some people even had an emotional connection to circles:

> We can't live without them.
> They are awesome.

Personal connections are usually the strong suit of any exhibition, and the exhibition team did well to create appreciative and resonant responses to the abstract and mathematical notion of a circle.

(vi) *Some of the exhibit-related programs engaged children and teachers in thoughtful and intrinsically motivated mathematical explorations and discussions.*

While the evaluator did not conduct pre- and post-tests of mathematics ability, it was possible to observe some of the children at Family Science Night engaging in deeply thoughtful mathematical reasoning about the circular phenomena, and puzzles that had been placed before them by CDM staff. Several students (especially the 4th and 5th graders) were able to reason impressively about circles in terms of their properties and their implications. Their performances probably reflect on the history and standing of the school, the economic and educational resources of the community, and the high-quality of facilitation available from the entire teaching staff who volunteered, but also they showcase the clarity, power, and accessibility of the activities created by CDM.

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Introduction

This report shares the purposes, methods and findings of the summative evaluation of *Secrets of Circles,* a 2,600 square-foot exhibition created by the Children's Discovery Museum of San Jose (henceforth referred to as CDM). The exhibition was the principle deliverable from a project originally called *Round and Round,* that was funded by the Informal Science Education program of the National Science Foundation.

Sue Allen (of Allen & Associates, an independent evaluation consultant) designed, wrote up, and oversaw implementation of the summative evaluation, in consultation with the project team from CDM who shared their goals and assumptions, research questions, and materials. Other independents and colleagues (listed in detail in the Acknowledgements section) made contributions to the overall design, data collection, pilot-testing of instruments, design of tracking software, specialized representations of visitors' movements, statistical calculations, and review of report drafts.

The goals of the entire *Round and Round* project were to provide a package of learning experiences in the geometry and physics of circles and wheels. The exhibition and related programs were designed to promote explorations of the many practical realizations of circles and wheels in everyday life. In particular, circles have unique properties that make them extremely effective as an engineering and design tool, and they are ubiquitous in cultures around the world.

The main idea behind the exhibition and related programs, as described by lead exhibit developer Peggy Monahan, was to communicate the message that:

> "The properties of circles determine why they're all around us. Every circle has a secret, that is, a reason for being a circle."

People experiencing the exhibition and programs would be encouraged to explore the basic properties of circles and circular forms (such as curves, spheres, and toroids), to appreciate the elegant use of circles in nature and by people around the world, and to investigate engineering applications of circular shapes such as wheels and gears.

The main audience for the exhibition was children aged 3-10 and their care-givers (parents or other adults). The team designed the exhibition and programs to be particularly inviting to families of Latino and Vietnamese descent, who comprise the largest ethnic groups in San Jose. In service of that goal, every label in the exhibition was trilingual, in English, Spanish, and Vietnamese. Also, the exhibition design had an overall Asian theme, with a full-sized Vietnamese round boat, heavy use of bamboo as a building material, and large Chinese-style umbrellas over many of the circular interactive exhibits. The use of large regions of bright color was hoped to resonate with the Latino community in particular. Along with the exhibition, the project team created a series of family workshops and other events, specifically targeting these communities, but these were completed in the earlier stages of the project, and have not been evaluated as part of this report. The report does include sections about the

responses of Latino and Vietnamese families to the exhibition, gleaned during special events or in-depth interviews with these groups.

Two versions of the *Secrets of Circles* exhibition were created, one to be permanently installed at CDM in San Jose, and the other to travel nationally. During the period when the summative evaluation was being conducted, the traveling version went to two different museums, the Strong National Museum of Play in Rochester, New York, and the Ecotarium in Worcester, Massachusetts. This allowed the evaluation to include some kind of cross-site study. The evaluator chose to conduct in-depth interviews with staff at each organization, to gain an organizational perspective on the exhibition and its supporting materials. In all, ten staff members were interviewed in depth about their experiences with the exhibition and with visitors who used it. These responses were integrated and are reported in a separate section of the report.

Finally, the project team created materials for a range of public and school programs, for community outreach, and for marketing. These were evaluated where feasible (the Family Science Night at a local elementary school), and their usefulness for museums who hosted the traveling exhibition was evaluated to the extent possible.

In brief, the summative evaluation was undertaken to determine the impact of the exhibition and related materials, in terms of attracting children and their care-givers, engaging them in math/science activities, communicating the special role of circles in science and culture, and welcoming families of Mexican and Vietnamese descent. The team was particularly interested in highlighting any significant differences, between younger children (3-5) and older children (6-10), between adults and children, and between males and females.

All the data on which this report is based was collected between November of 2006 and January of 2007, except the interviews with staff at the remote museums, which took place in August and September of 2007, once the exhibition had begun to travel.

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Tracking and Timing Study of Exhibition Use

Purpose

A tracking and timing study was conducted to investigate the ways the exhibition was used by the target audience: viz., children aged 3-10 and their care-givers. Because the Children's Discovery Museum further distinguished between children aged 3-5 and children aged 6-10, the tracking study was conducted with equal groups of three types of visitors: (i) 3-5 year olds, (ii) 6-10 year olds, and (iii) adults with children in these age ranges.

The main research questions for this study were:

a) *How long did visitors spend in the exhibition?*
b) *How many elements did visitors stop at? How does this compare with other exhibitions?`*
c) *Within the exhibition, which elements were visitors most likely to stop at (i.e., which had the highest attracting power)?*
d) *Which elements in the exhibition were most sustaining (i.e., had the longest holding times)?*
e) *What were the overall patterns in which visitors moved among the elements?*
f) *What kinds of behaviors did visitors display in the exhibition?*

Methods

A total of 113 visitors were unobtrusively tracked and timed, and their behaviors were recorded while they were in the exhibition. Data collection took place over 11 days between November 19 and December 31, 2006. To avoid field trips and focus on use of the exhibition by the primary audience of multigenerational families, all days were chosen to be either weekend days (9 of 11) or weekdays in the last week of December, with crowding levels comparable with those on weekends (2 of 11). Visitors were observed between 10.00 am and 4.15 p.m., stopping at least 45 minutes before museum closing time so that visitors would not be using the exhibition hastily at the last minute. On Sundays, when the museum opened to members only from 11.00 a.m. to noon, observations were started at noon.

All visitors tracked were members of the primary audience for the exhibition: viz., children aged 3-10 and their care-givers, moving in multigenerational groups. Three independent subsamples were studied: children aged 3-5, children aged 6-10, and adults in the company of such children. In all, 114 people were observed, with approximately equal numbers in each age range.

Observations were recorded using a tablet PC running FileMaker Pro. To facilitate data entry on the floor, we created a layout in our FileMaker file similar to the floor plan. Buttons representing the different exhibit components called scripts that recorded when the visitor being track stopped at that component and when s/he left that component. The sequence of timed exhibit stops made up that visitor's trail through the exhibition. A more detailed

description of this data collection method can be found in Ma (2007).[6]

Sampling technique:
The data collector selected the Nth visitor to cross the exhibition entry threshold, with N being a random number between 1 and 5, computed independently for each data point. This was done to avoid the pilot-study finding that choosing every third visitor seemed to favor adults over children at this location. If the selected visitor was clearly under 3 years old, the next visitor was selected. In cases of doubt, the child was tracked and later removed from the study if they were found (on interviewing the accompanying adult) to be younger than 3.

Definition of a stop:
For this study, we defined a stop as occurring whenever the observed visitor stood or sat still, within 4 feet of the element, with their attention clearly on the element, for a minimum of 1 second. This is similar to Serrell's well-known method[7], except that the efficiency and precision resulting from the use of computer technology allowed the data collector to capture stopping times as short as 1 second, rather than Serrell's minimum of "2 to 3 seconds." In fact, the results were not significantly different from those that Serrell's method would have generated, since only 4 cases of 1-second stops were recorded, out of a total of over 1800 individual stops.

Recorded behaviors:
In addition to recording which elements visitors stopped at, and for what durations, the data collector also recorded whether the observed visitor engaged in various behaviors at each element. For each element the behavior was either observed or not observed, creating a binary ("yes/no") scoring system.

The behaviors observed were:

- Sat at an element;-
- Called over another visitor to the element;
- Pointed at an element;
- Took photo (with own camera);
- Physically used an exhibit (details given in Appendix C);
- Read an "in-depth graphic" (multi-paged exhibit label, shown in Appendix B) out loud; *
- Read, or looked intently at, an "in-depth graphic" silently; *
- Read something other than an in-depth graphic out loud (It was impossible to reliably determine whether visitors were reading labels silently or not);
- Was accompanied by another visitor, defined as any other visitor being engaged at the same element at the same time, or taking clear steps to move towards it and stopping within 10 feet of it;

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[6] Ma, J. (2007, July). New tools for timing and tracking. Poster presented at the meeting of the Visitor Studies Association, Ottawa, Canada.
[7] Serrell, B. (1998). Paying attention: Visitors and museum exhibitions. Washington, DC: American Association of Museums.

- Talked with an adult; *
- Talked with a child; *
- Physically used an exhibit alongside an adult (at the same time as, or clearly took turns with);
- Physically used an exhibit alongside a child.

* These behaviors are subtle enough that their observation could not always be guaranteed. Because of this, the frequencies of these behaviors should be considered a lower bound.

Interactions with others, such as talking and using an exhibit, were defined inclusively (i.e., with any person, not just a person in the family group) partly to legitimize interactions among strangers, and partly because the cognitive demands of the tracking task made finer distinctions unfeasible. One implication of this is that large, multi-access elements (such as Ripple Table) tend to show high levels of interaction, even though the kinds of behaviors actually taking place might have been independent rather than collaborative.

Figure 1: Introductory large-format signs: S1 (left) and sign with hole (right)

Not all elements of the exhibition supported all behaviors. For example, the Circles Diorama did not support "use" in the sense defined here, because it could not be physically interacted with beyond stopping, looking, pointing, and talking. Similarly, the benches and signs did not

support physical use. The exception was the green introductory sign which had a circle that children often crawled through (shown in Figure 1).

Also, some exhibit elements did not have an "in-depth graphic," the multi-page exhibit label (shown in Appendix B) that provided information about the exhibit and the circle-related principle underlying it.

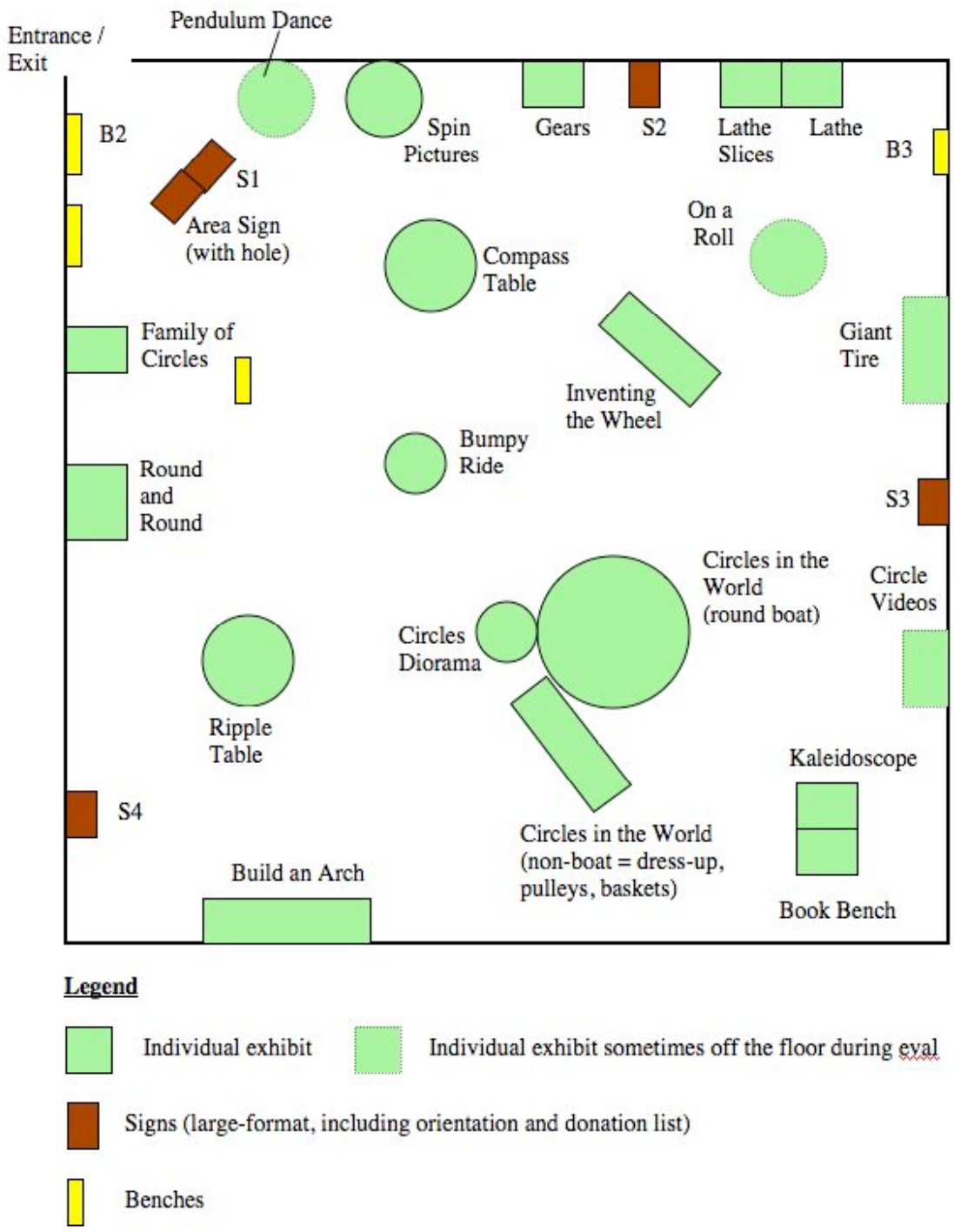
Appendix C summarizes the exhibition elements in terms of whether or not they supported each of the behaviors recorded. In other words, this table represents a baseline of possibilities for exhibit-related behaviors. The appendix also includes explicit definitions of "use" for each exhibit, i.e., what kinds of physical interactions were counted as "using" that exhibit.

Demographic information:
After the observed group left the exhibition, the data collector followed them and asked one of the adults in the group several brief questions: the size of the visiting group, the ages of the children, whether or not this was the observed person's first visit to *Secrets of Circles,* the person's home language, and zip code. The data collector estimated the age of all adult group members.

Exhibition Elements and Floor-Plan

Figure 2 shows the floor-plan of the *Secrets of Circles* exhibition at the time of its summative evaluation. The exhibition included 20 exhibits (individual elements, mostly interactive), 5 large-scale signs or banners, and 4 benches. The exhibition was located in a single rectangular room with a single door at one corner, that served as both an entrance and exit.

Figure 2: Floor-plan of *Secrets of Circles* Exhibition



Appendix A gives a complete list of the 20 individual exhibits, along with a brief description and photograph of each. It also includes some examples of the large-format signs, known to the team as "banners."

Visitors in the Tracking and Timing Study

Table 1 summarizes the demographic data for the 113 visitors who were tracked, timed, and observed. The information was gleaned during brief interviews after the visitors had been followed through the exhibition.

Table 1: Visitors who were tracked and timed

Demographic / background factor	Categories	(N=113)
Gender	Female	42%
	Male	58%
Age	3-5	34%
	6-10	34%
	Adult	33%
Region currently lived in	San Jose	19%
	Santa Clara County (excl. San Jose)	27%
	Santa Cruz County	3%
	San Benito / Monterey	3%
	North Bay	10%
	East Bay	18%
	Central California	4%
	Northern California	1%
	Southern California	4%
	Outside California	5%
	Unknown	6%
Gender and Age (detail)	Woman	17%
	Man	16%
	Girl	25%
	Boy	42%
Group size	1	1%
	2	21%
	3	28%
	4	21%
	5	12%
	6	2%
	7+	16%

Language spoken at home*	Target languages: **English** **(English only)** **Spanish** **Vietnamese**	 76% (65%) 1% 4%
Language spoken at home* (cont.)	Chinese / Mandarin / Cantonese Other Asian languages All languages not listed above	12% 9% 9%
Seen exhibition before	Had seen *Secrets of Circles* before First time seeing *Secrets of Circles* Uncertain	29% 66% 4%

- These numbers may add to more than 100% because of families who gave multiple answers.

Summary of Findings

Overall, visitors spent a median of 14.6 minutes in the exhibition, significantly longer than exhibitions of similar size. The amount of time spent did not vary significantly with age, group size, gender, or prior experience with the exhibition.

Visitors used the entire gallery, and tended to move from one interactive exhibit to another one nearby. Visitors stopped at a median of 11 elements (44% of available elements), which is significantly more than the reported average for museum exhibitions.

Overall, 84% of visitors (including adults and children as young as 3) interacted physically with interactive exhibit elements. Visitors tended to use the individual elements in multi-generational groups, talking and interacting together. Parents did not sit back and watch.

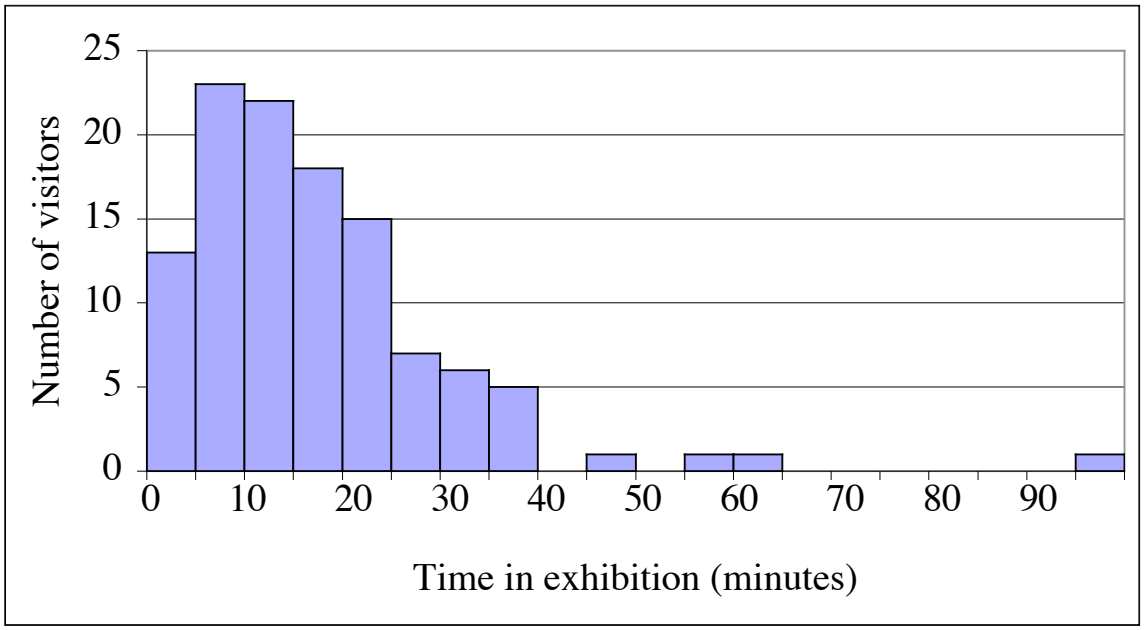
A few differences were observed between the use of the exhibition by different subgroups of visitors: Girls spent marginally longer than boys in the exhibition; men stopped at more elements than women; and the Round Boat attracted more girls than boys, and engaged younger children for longer times than older children.

Detailed Findings

a) How long did visitors spend in the exhibition?

The histogram in Figure 3 shows how long visitors spent in the *Secrets of Circles* exhibition.

Figure 3: Total time that visitors spent in exhibition, N=113



This distribution is "right-skewed" in shape, meaning that more visitors fall to the right of the peak than the left. This is typical of interpretive exhibitions: roughly 90% of them have a similar shape (Serrell, 1998).

Average Time Spent

What is unusual about this exhibition is not its shape but its scale. Serrell's analysis of 104 interpretive exhibitions led her to offer an equation that relates average time visitors spend to the size of the exhibition. Her data were roughly linear:

> Average time spent (in minutes)
> =1.76 x Exhibition size (in thousands of square feet) + 6.42 (p.22)

For an exhibition size of 2,600 square feet (the size of the *Secrets of Circles* exhibition while it was at CDM[8]), this equation predicts a value of 11.0 minutes. However, the measured average time visitors spent in *Secrets of Circles* was 17.4 minutes, over 50% longer than this predicted value. Clearly visitors were spending significantly longer times in this exhibition than is the average for the field.

Median Time Spent

[8] The exhibition was actually designed to fit into 2,000 square feet. The timing data would be even more impressive if compared to other exhibitions of this smaller size, but *Secrets of Circles* was not studied in a smaller space, and holding times might differ, so the observed figure of 2,600 square feet is used throughout this report.

Because of the right-skewed nature of the time distribution, the "typical time" spent in the exhibition is probably better represented by the median than the average. The median time for *Secrets of Circles* was 14.6 minutes: in other words, half the visitors in the tracked sample spent more than this time, and half spent less than this time, in the exhibition.

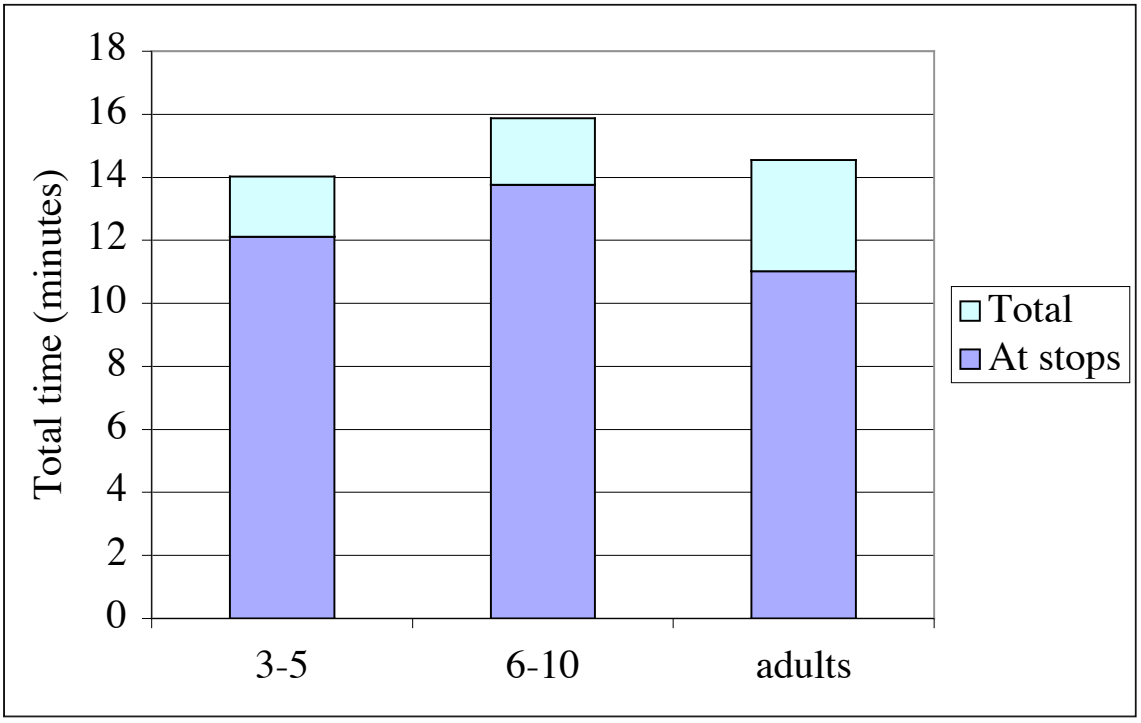
Sweep Rate Index

A related measure proposed by Serrell (1998) is "Sweep Rate Index (SRI)[9]," which assesses the speed with which visitors move through an exhibition space. A low number means visitors are moving slowly, presumably being engaged by what they discover. *Secrets of Circles* had a Sweep Rate Index of 150.0, which is approximately half the median (SRI=284) for a large range of studied interpretive exhibitions. In other words, this is another way to state the fact that visitors were spending a long time in the exhibition.

(i) Time spent by different age groups

The full bars in Figure 4 show the same data, but split into the three different age groups: 3-5, 6-10, and adults. These times showed no significant differences based on age. In other words, visitors of all ages spent about the same amount of time in the exhibition.

Figure 4: Total time that visitors of different ages spent in exhibition, N=113



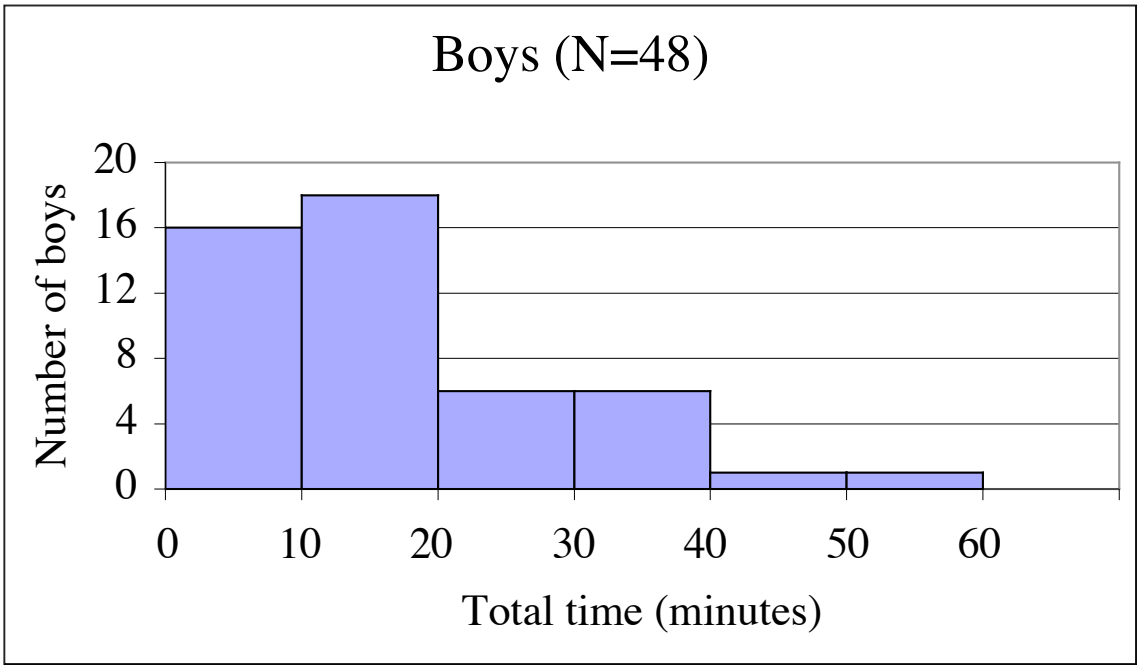
[9] The SRI is calculated by dividing the square footage of an exhibition by the average total time in minutes.

This figure also shows a breakdown of the time visitors spent into two parts: (a) the time they spent actually stopped at exhibition elements (shown as darker) and (b) the time they spent moving between elements, sitting on benches, or talking to each other while not looking at exhibition elements. In other words, the time they spent at stops represents the time that visitors were actively attending to exhibition elements. The graphs show that this time was a high fraction of the total time in the room: 83% over all visitors. As might be expected, children had a higher percentage time attending than adults (87% versus 76%, $t(62)=5.07$, $p<0.001$[10]), but even the adults were stopped at elements other than benches for the great majority of their time.

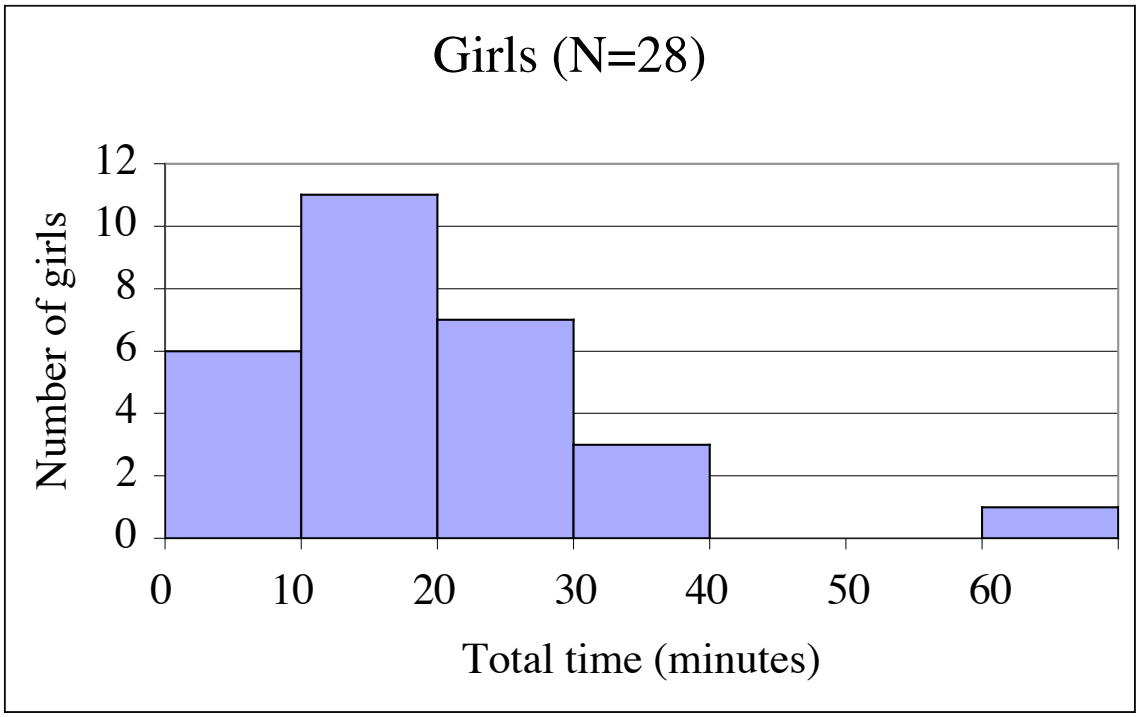
(ii) Time spent by different genders

Figure 5 shows a comparison of the distribution of total exhibition times of boys versus girls (aged 3-10). The fact that there are more boys in the sample was not by design; the systematic sampling procedure selected children randomly, and the difference in number is not statistically different from an equal distribution.

Figure 5: Total time spent in the exhibition by boys versus girls



[10] In social science research, findings are usually reported when their p-value is less than 0.05. This means that the probability of finding such a result by chance is less than 0.05. Findings with p-values between 0.05 and 0.10 are sometimes reported as "trends," though in this report we keep fairly conservative because the large number of analyses conducted makes it likely that some will occur by chance, even with a threshold of p=0.05.



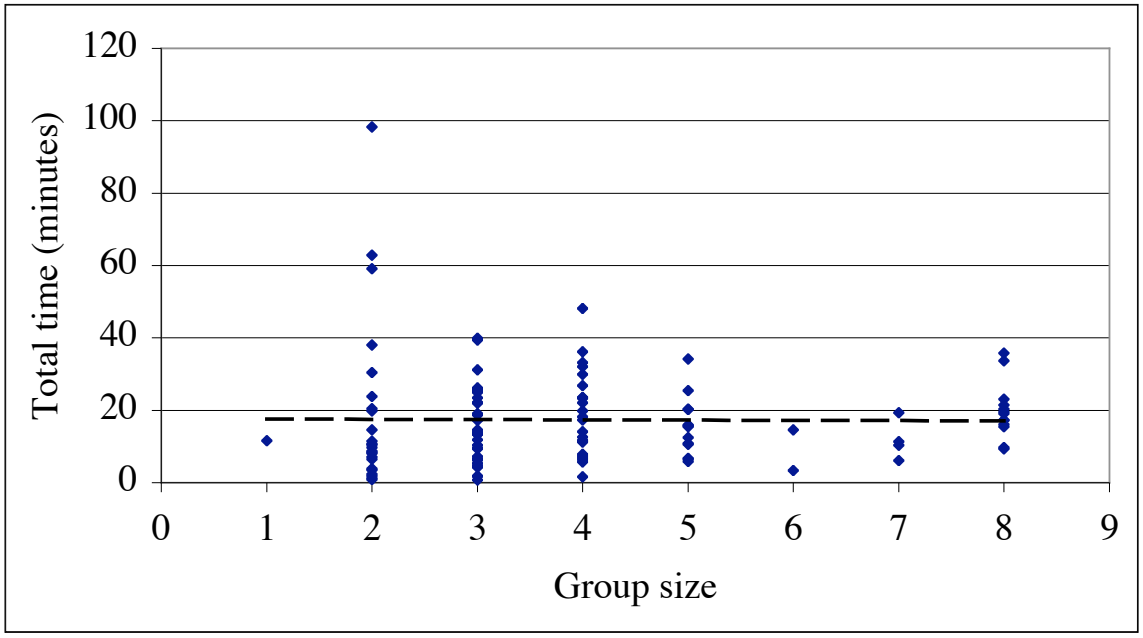
The comparison data does, however, show a marginally-significant difference in the amounts of time spent by the boys versus the girls, ($t(71)=1.94$, $p=0.056$, when logs of times are taken to symmetrize the skewness). The girls spent a median time of 19.0 minutes, over 50% longer than the boys median time of 12.2 minutes. The histograms show that much of this difference was in the short-duration visits (under 5 minutes): more boys than girls visited the exhibition for very short periods.

A comparison between the total times of men and women showed no significant differences.

(iii) Time spent by groups of different sizes

Figure 6 shows how much time groups of different size spent in the exhibition. A trend line drawn through the dataset has no slope, indicating that the size of the group had no significant effect on the time spent in the exhibition. On the other hand, it is interesting to note that the variation in durations seems to decrease as the group gets larger. Perhaps small groups have more freedom to spend long times with something that they find particularly engaging, or to move on from something unappealing, whereas larger groups may be less agile in the choices they make, and thus spend a more average time in order to stay together.

Figure 6: Total time spent in the exhibition by groups of different size



(iv) Time spent by first-time viewers versus repeat visitors

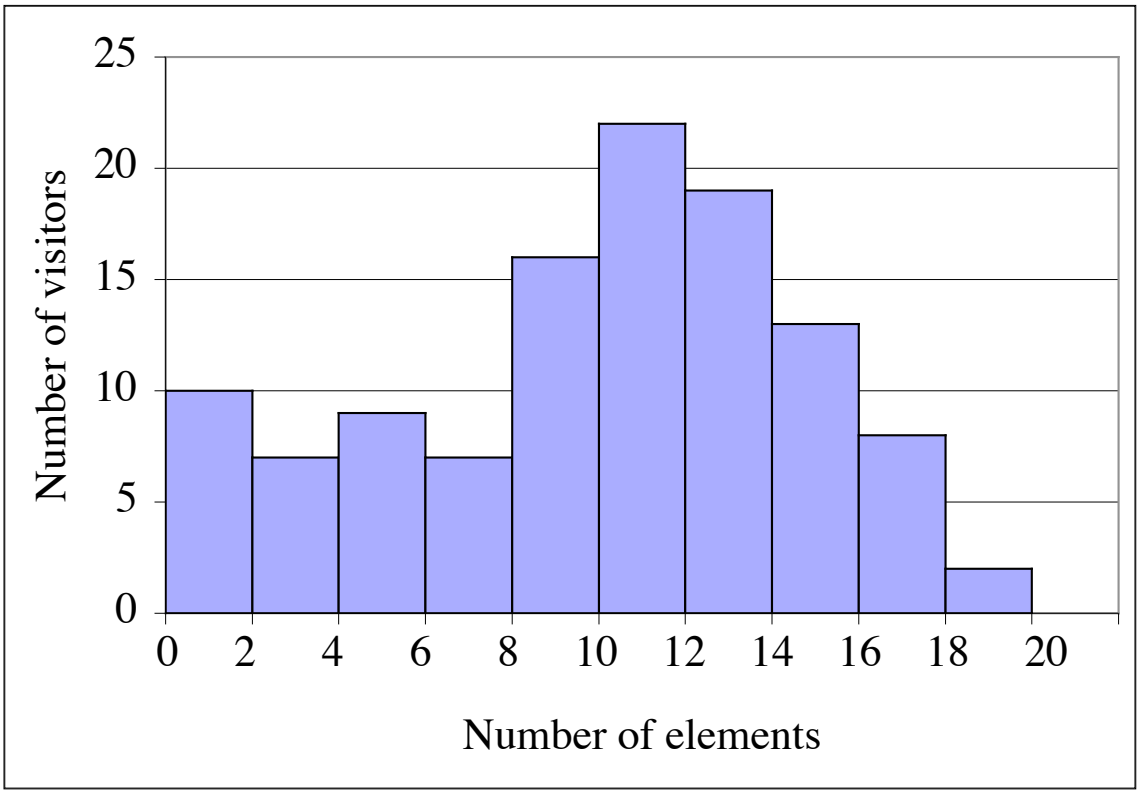
There was also no significant difference between the times spent in the exhibition by people who had never seen it before, (66%) and those who had (29%). This shows that the exhibition not only had long holding times for visitors, but it could sustain them through repeated explorations.

b) How many elements did visitors stop at? How does this compare with other exhibitions?

In this study, we have used Serrell's (1998) definition of the "elements" of an exhibition as "all the physical spaces where there is something for self-guiding visitors to do, conceptually and physically. For example, elements include places to stop to look more closely at an object or phenomenon, read a label, interact with a device, or watch an audio-visual program." (p.11). Using this definition, we have included large-format signs as elements because visitors can stop and read them if they choose, but not the benches which, while important, don't really offer visitors something conceptual to do. By this definition, the *Secrets of Circles* exhibition contained 25 elements.

Figure 7 is a histogram of the number of such elements visitors stopped at. The minimum possible is 1 (in order for the visitor to be included in the sample), and the maximum is 25 (if a visitor were to stop at every element at least once). If a visitor stopped twice at the same element, they were considered as stopping at one element, but with the holding time being the sum of the two individual times.

Figure 7: Number of elements that visitors stopped at (N=113)



Overall, this distribution of times is close to symmetrical, and would probably be classified by Serrell (1998) as "bell-shaped." Roughly 30% of interpretive exhibitions have this shape. To the extent that it is slightly asymmetrical, it tends toward being "left skewed," (i.e., the peak at 10-12 elements falls closer to the maximum of 20 than to the minimum of 0). This means that a slightly larger fraction of the visitors stopped at many of the exhibit elements, which is unusual for an exhibition. The most common distribution Serrell found was right-skewed (with the peak of the distribution falling nearer the "0"), which would show that most visitors saw few of the elements.

The median number of stops was 11 (excluding benches), out of 25 elements. This number was essentially independent of age.

(i) Time spent by different subgroups of data

Statistical comparisons showed no differences between the number of elements stopped at by boys versus girls, first-time versus repeat users of the exhibition, or groups of different sizes.

There was a difference, however, between the stopping behavior of men versus women: Men stopped at 11.5 of the 25 possible elements (median), while women stopped at 9.0 ($t(32)=2.49$, $p=0.018$).

(ii) Percentage of Diligent Visitors (%DV)

Serrell proposes another measure of exhibition use: the percentage of "diligent visitors." A diligent visitor is one who uses more than half of the elements in an exhibition (in this case, 13 or more elements). In our sample of *Secrets of Circles* visitors, the percentage of diligent visitors was 42%. [11]

In her review of 110 exhibitions for which comparable data was available, Serrell found that the median %DV was 24%. In other words, there were 75% more visitors behaving diligently in *Secrets of Circles* than the median number from Serrell's exhibitions. Once again, this shows the high degree of use to which the elements of the exhibition were put by visitors.

Comparisons of %DV among the different age groups studied showed no significant differences, showing that the exhibition was thoroughly used by all ages.

(iii) Thoroughness of use

Finally, Serrell proposes that "thoroughly used exhibitions" are those that have both low Sweep Rate Index (i.e., visitors move slowly), and high %DV (i.e., visitors use most of the elements). Under this characterization, *Secrets of Circles* falls into the most desirable quadrant of exhibitions: slower-than-average sweep rate (150 sq.ft. per minute) and higher-than-average %DV (42% of visitors). In short, this exhibition was thoroughly used, an attribute particularly valued by Serrell as showing high investment by visitors as well as economic efficiency of the exhibition's construction. Interestingly, Serrell found that this desirable quadrant of use contained relatively few science museum exhibitions, making this result particularly unusual, if one considers *Circles* to be closer to a science museum exhibition than Serrell's other categories (history, natural history, art, and aquariums).

c) Within the exhibition, which elements were visitors most likely to stop at (i.e., which had the highest attracting power)?

Table 2 lists the exhibition elements in order of their attracting power.

[11] This figure does take into account the fact that four exhibits were only present on some of the data collection days. On those days, the number of elements in the exhibition was appropriately reduced before calculating percentages of use by each visitor.

Table 2: Attracting power of exhibit elements, N=113

Element (exhibit / sign / bench)	Number who stopped at that element	Percent of all visitors
Ripple Table	85	75%
Inventing the Wheel	83	73%
Compass Table	82	73%
Spin Pictures	79	70%
Round and Round	79	70%
Giant Tire	*	68%
Family of Circles	72	64%
Pendulum Dance	*	63%
On a Roll	*	61%
Bumpy Ride	66	58%
Gears	66	58%
Circles in the World: Boat	62	55%
Circle Videos	*	54%
Build an Arch	58	51%
Circles in the World: Non-boat	52	46%
Lathe	47	42%
Kaleidoscope	37	33%
Circles Diorama	35	31%
Lathe Slices	31	27%
Intro Sign with hole	24	21%
Book Bench	12	11%
S1 (sign)	10	9%
B4 (bench)	6	5%
B3	4	4%
S2	4	4%
B1	3	3%
B2	3	3%
S4	3	3%
S3	2	2%

* These elements were off the floor for redesign during some of the days of data collection. Their percentages of stoppers have therefore been calculated based only on those days during which they were on the floor and available for public use.

There were no significant differences by age group on any of the elements, except the Book Bench, where more adults stopped than children (chisq(1) = 7.01, $p<0.01$) but these were very small numbers so they may not be reliable.

Two elements showed a difference based on whether visitors had seen the exhibition before. Specifically, Compass Table and Inventing the Wheel were both more likely to attract visitors on their first time in the exhibition than on subsequent visits. (Compass Table: 79% versus 58%, chisq(1)=5.08, p=0.02; Inventing the Wheel: 80% versus 61%, chisq(1)=4.48, p=0.03). It is not clear why these two elements particularly dropped off in their attracting power. It may be that they supported a more limited palette of experiences than some of the other interactives (such as Circle Videos, Pendulum Dance, Gears), and thus repeat visitors might have felt they had "already done" these. On the other hand, the effect may simply be an artifact of these two elements having high attraction to begin with, the chi-squared test being more sensitive to percentage changes where there is a "ceiling effect" (i.e., where most visitors stopped).

Four elements showed gender differences in their attracting power:

(i) Circles in the World, the Round Boat element was more attractive to girls (75%) than boys (44%), perhaps because it involved dressing up in pretty fabrics and hats, an activity that is stereotypically more attractive to girls. (chisq(1)=6.99, $p<0.001$).

(ii) Bumpy Ride was more attractive to men (67%) than women (26%) (chisq(1)=6.06, p=0.01).

(iii) Family of Circles was more attractive to men (83%) than women (42%) (chisq(1)=6.68, $p<0.01$).

(iv) Round and Round was more attractive to men (89%) than women (53%) (chisq(1)=5.82, p=0.02).

(v) Ripple Table was more attractive to men (94% than women (68%) (chisq(1)=4.08, p=0.04).

Apart from the Round Boat usage by girls, the rest of these gender differences (ii – v) can be most simply accounted for by the overall finding from the previous section, that men tended to stop at more of the exhibit elements than women.

d) Which elements in the exhibition were most sustaining (i.e., had the longest holding times)?

(i) Overall element rankings

Table 3 lists all 30 elements of the *Secrets of Circles* exhibition, in order of holding times. Each holding time is the median of the holding times for all visitors who stopped at that element (also shown in the table, in the column "S" for number of stoppers). Medians were calculated rather than averages because holding times for exhibitions and their elements typically have distributions that are asymmetrical (skewed right) rather than bell-shaped (Gaussian). While every element except bench B2 had at least one stop, the elements with very small numbers of stops should be considered as having holding times with correspondingly high uncertainties.

Table 3: Holding times for all visitors, N=113

Element (exhibit / sign / bench)	Median holding time (seconds)	Number of stoppers (S) at that element
B4 (bench)	143.5	6
Circle Videos	107.0	57
Spin Pictures	97.0	79
Compass Table	97.0	82
Gears	80.0	66
Giant Tire	69.0	38
Circles in the World (boat)	61.5	62
Lathe	56.0	47
B1	55.0	3
Kaleidoscope	54.0	37
On a Roll	54.0	64
Ripple Table	51.0	85
Inventing the Wheel	48.0	83
Bumpy Ride	42.5	66
Build an Arch	36.0	58
Pendulum Dance	33.0	38
Circles in the World (non-boat)	32.0	52
B3	31.5	4
Family of Circles	30.0	72

Element (exhibit / sign / bench)	Median holding time (seconds)	Number of stoppers (S) at that element
Round and Round	24.0	79
B2	21.0	3
Book Bench	21.0	12
Lathe Slices	18.0	31
S3 (sign)	12.5	2
S4	8.0	3
Circles Diorama	7.0	35
S2	6.5	4
Intro sign with hole	5.5	24
S1	5.0	10

Points of interest in Table 3:

- The element with the longest holding time was the bench B4, which was in a central location from which the rest of the gallery could easily be watched. Of the 6 people who sat on the bench, 4 were adults, presumably watching their children interact with the surrounding exhibits.
- The top 3 exhibits on the list were all elements that supported multiple kinds of interaction, as well as new ways of representing or seeing circles.
- Unsurprisingly, the elements with the longer holding times were mostly interactive exhibits.

(ii) Element holding times for children of different ages

Tables 4 and 5 also list ranked holding times, but for children separated into the two key age categories: 3-5 and 6-10. Asterisks mark elements that showed significant differences between the holding times of younger and older children.

Tables 4 & 5: Holding times for children of the two targeted age groups

Children 3-5 (N=38)

Element (exhibit / sign / bench)	Median holding time (sec's)	Number of stoppers (S) at that element
Book Bench	509.0	2
Gears	134.0	24
* Circles in the World (boat)	122.0	23
Circle Videos	99.0	22
Compass Table	83.0	27
Spin Pictures	81.5	30
Giant Tire	63.0	17
On a Roll	63.0	19
Circles in World (non-boat)	62.5	16
Lathe	56.0	13
Inventing the Wheel	54.0	25
Kaleidoscope	50.0	10
Build an Arch	49.0	16
Ripple Table	38.0	25
* Family of Circles	36.0	25
Bumpy Ride	33.0	24
Round and Round	33.0	28
Pendulum Dance	32.0	15
B2	18.0	1
Lathe Slices	15.0	9
S1	13.0	4

Children 6-10 (N=38)

Element (exhibit / sign / bench)	Median holding time (sec's)	Number of stoppers (S) at that element
B4	702.0	1
Circle Videos	174.0	18
Compass Table	98.0	29
Spin Pictures	91.5	26
Giant Tire	88.0	19
Gears	74.0	21
Bumpy Ride	56.0	25
B1	55.0	1
Ripple Table	54.0	30
Lathe	51.0	18
Inventing the Wheel	49.0	31
On a Roll	46.5	26
B2	43.0	1
Kaleidoscope	41.5	12
Book Bench	36.5	2
* Circles in the World (boat)	35.0	19
Pendulum Dance	35.0	15
B3	34.0	1
Build an Arch	33.0	20
Circles in the World (non-boat)	32.0	23
* Family of Circles	30.5	24

Element (exhibit / sign / bench)	Median holding time (sec's)	Number of stoppers (S) at that element
Circles Diorama	9.5	14
B4	8.0	1
*Intro sign w/hole	7.0	11
S3	6.0	1
S2	4.0	1
B1		0
B3		0
S4		0

Element (exhibit / sign / bench)	Median holding time (sec's)	Number of stoppers (S) at that element
Round and Round	23.0	25
Lathe Slices	18.0	14
S2	8.0	1
Circles Diorama	5.5	12
* Intro sign w/ hole	3.0	7
S1	2.0	2
S3		0
S4		0

Points of interest in Tables 4 and 5:

- The round boat in Circles in the World engaged younger children for longer times; they tried on the clothes and hats, sat in the boat, and used the oars to row on an imaginary ocean. This age difference is not surprising, given that dramatic or sociodramatic pretense play generally reaches a peak in children aged 4 to 5 years, before declining (Santrock, 2005, p. 369).[12]
- The green introductory sign with the large hole cut in it, likewise, sustained younger children for longer than older children. Although statistically significant, this difference was only a few seconds (7.0 seconds versus 3.0 seconds), and probably reflects the fact that the younger children were less physically skilled at getting through the opening, since they had equal rates of interactivity with older children but higher rates of accompaniment by adults.
- Family of Circles engaged younger children for slightly longer than older children (36.0 seconds versus 30.5 seconds), for reasons that were not apparent.

(iii) Element holding times for adults versus children

Table 6 lists the exhibition elements in order of their holding times for adults.

[12] Santrock, J.W. (2005). Children (Eighth Edition). New York: McGraw-Hill.

Table 6: Holding times for adults, N=37

Element (exhibit / sign / bench)	Median holding time (seconds)	Number of stoppers (S) at that element
Giant Tire	156.5	2
B4	143.5	4
Spin Pictures	108.0	23
Circle Videos	108.0	17
Compass Table	105.5	26
Gears	64.0	21
Lathe	64.0	16
Kaleidoscope	59.0	15
Ripple Table	56.0	30
On a Roll	55.0	19
B1	49.0	2
Circles in the World (boat)	47.5	20
Inventing the Wheel	38.0	27
Bumpy Ride	34.0	17
Lathe Slices	30.5	8
Build an Arch	30.0	22
Pendulum Dance	30.0	8
B3	29.0	3
* Family of Circles	23.0	23
B2	21.0	1
Circles in the World (non-boat)	20.0	13
S3	19.0	1
Round and Round	18.5	26
Book Bench	11.5	8
S2	8.5	2
S4	8.0	3
Intro sign with hole	7.0	6
Circles Diorama	6.0	9
S1	5.0	4

Points of interest in Table 6:

- Family of Circles was the only element with significantly different engagement times between adults and children: Adults engaged with this exhibit for a median of 23.0 seconds, while the median for children was 32.0 seconds. Perhaps what is more interesting than this difference is that fact that it was so rare: for most elements there were no significant differences between the holding times for adults and children; adults were stopped at the elements of the exhibition essentially the same durations as the children they accompanied. They were not sitting back and disengaging from their children's activity.[13]

(iv) Element holding times for different genders

Comparisons showed no significant differences in the holding times of men versus women, or boys versus girls.

(v) Element holding times for first-time versus repeat users of the exhibition

Table 7 shows that four of the exhibits had significantly different holding times for visitors who were first-time users of the exhibition versus those who had used the exhibition before.

Table 7: Elements with different holding times by repeat visitors

Element (exhibit / sign / bench)	**Median holding time of <u>first-time</u> exhibition users (seconds)**	**Median holding time of <u>repeat</u> exhibition users** (seconds)
Inventing the Wheel	57	39
Ripple Table	56	30
Circle Videos	94	202
Circles in the World (boat)	48	104

[13] At this point we remind the reader that we defined a stop as occurring whenever the observed visitor stood or sat still, within 4 feet of the element, with their attention clearly on it. This means that adults did not have to be interacting with an exhibit to be stopped at it, but they did need to be close to it and attending to it.

Interestingly, not all the exhibits had shorter holding times for repeat visitors. Inventing the Wheel and Ripple Table did sustain repeat visitors for shorter times, perhaps because they both offered a limited palette of physical interactions, but Circle Videos and Circles in the World (Round Boat) more than doubled their holding times for repeat visitors. One might speculate as to the reasons for this: These two elements only had intermediate attracting power, and so were not the elements that immediately grabbed visitors' attention. They both had a transparent design, in the sense that it was readily apparent what one could do with them, as compared with some of the other physical interactives. Perhaps visitors on their first visit decided to limit their time with these until they had seen what other elements had to offer. But on repeat visits, when some of the exhibition's novelty had worn off, these were two that supported delightful extended experiences. The round boat offered a chance to be immersed in a fantasy world, complete with costuming, and to practice rowing with a wooden oar and perhaps sharing a story about what one was doing with family members. The video was an extensive and highly imaginative collection of video clips with a circles theme, and its Spin Browser format allowed visitors to view the videos frame-by-frame or at high speed. Both of these two exhibits were multimodal, combining a range of interactive possibilities with great aesthetic beauty. And both offered visitors a large area for viewing and participating in the activity; in fact, several interactions were noticed among strangers who were coordinating roles or rowing (in the case of the Round Boat) or who were waiting their turns to have control (in the Circles Videos). These two elements had many of Borun & Dritsas' key characteristics for supporting family learning[14]: they were multi-sided (or at least viewable from many locations), multi-user (or at least multi-viewer), accessible to both adults and children, served by brief and easily readable text, and were relevant to visitors' prior knowledge and experience.

e) <u>What were the overall patterns in which visitors moved among the elements?</u>

Figure 8 shows a Movement Map for all 113 visitors who were unobtrusively tracked as they moved through the exhibition. The map was generated with a custom-designed application that reads the output from a FileMaker file, and shows which elements immediately preceded or followed any single element in the exhibition (Ma, 2006).[15] The grey shapes represent the different elements (exhibits, benches, and signs), with lighter shades showing more frequently visited elements.[16] The purple triangles show the entrance / exit to the exhibition. The lines show the number of visitors who moved from component to component, with green indicating

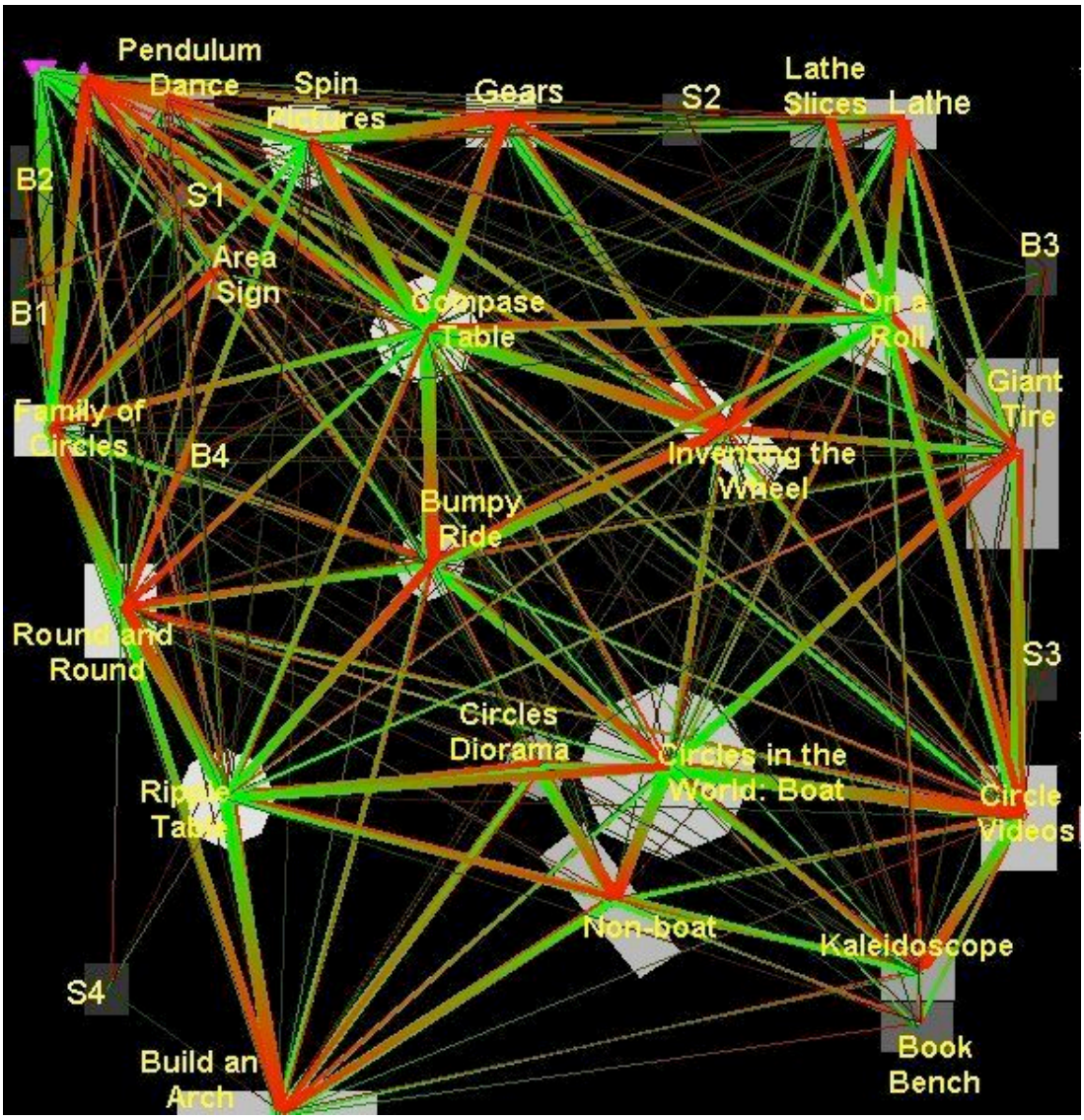
[14] Borun, M. & Dritsas, J. (1997). Developing family-friendly exhibits. Curator, 40(3), 178-196.

[15] Ma, J. (2006, May). Timing and Tracking for the Mind In Progress Section. Retrieved September 17, 2007, from http://www.exploratorium.edu/partner/pdf/mindCamMay_rp_03.pdf

[16] Because these maps aggregate data over multiple days, they cannot account for the fact that four exhibits (viz., Circle Videos, Giant Tire, On a Roll, and Pendulum Dance) were sometimes off the floor. In other words, these four exhibits might have an artificially low brightness as well as artificially thin connecting lines.

the start and the red indicating the end of each segment. The thickness of a line represents the number of visitors who traversed that segment.

Figure 8: Movement Map for all 113 tracked visitors



This Map highlights the following aspects of visitors' overall movements between elements of the exhibition:

(i) The whole room is used by visitors; there are no large dead spaces.
(ii) Interactive exhibits dominate: The interactive exhibits glow brightly, showing that far more people stopped at them than at the signs or benches, which show as dark grey.

(iii) Short segments are most common: The thickest lines are between neighboring interactive exhibits, showing that visitors tended to go toward an exhibit that was closest to the one they were currently using.

(iv) The dense mesh of thin lines shows that almost every segment between exhibits has been traversed by at least one person: visitors are making active choices about where to go next.

Figures 9, 10, and 11 show Movement Maps for each of the targeted age ranges: 3-5, 6-10, and adult. The maps look very similar, showing that visitors of all ages moved in similar ways through the exhibition. This may simply reflect the tendency of families with young children to staying together for the most part, or may show that the exhibition had similar patterns of appeal for different age groups. The only obvious difference, the low use of Giant Tire by adults compared with children, is actually an artifact of the data collection process: during that time the adult segment of the sample was being collected, this element was almost always off the floor for redesign.

Figure 9: Movement Map for 3-5 year olds (N=38)

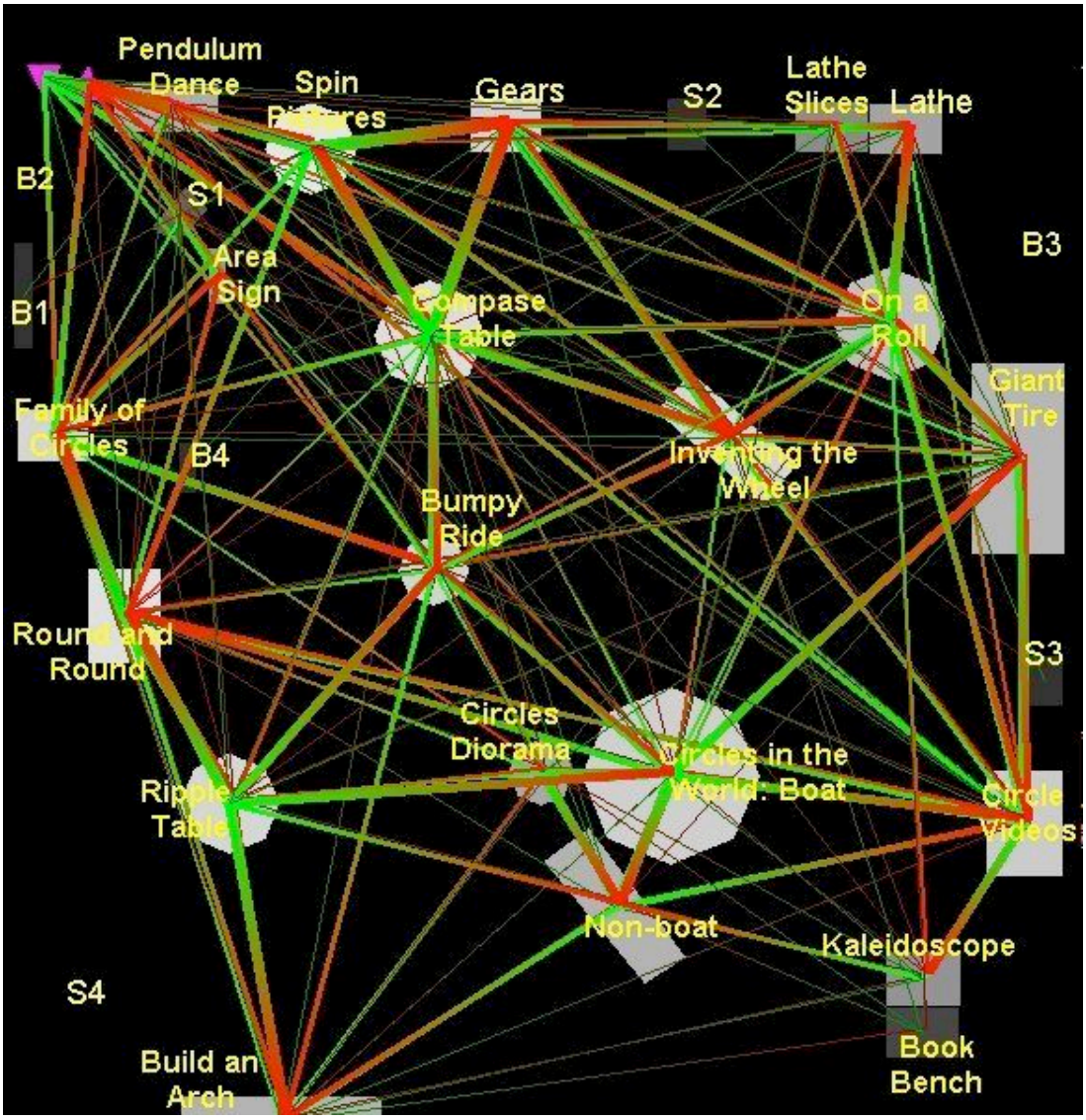


Figure 10: Movement Map for 6-10 year olds (N=38)

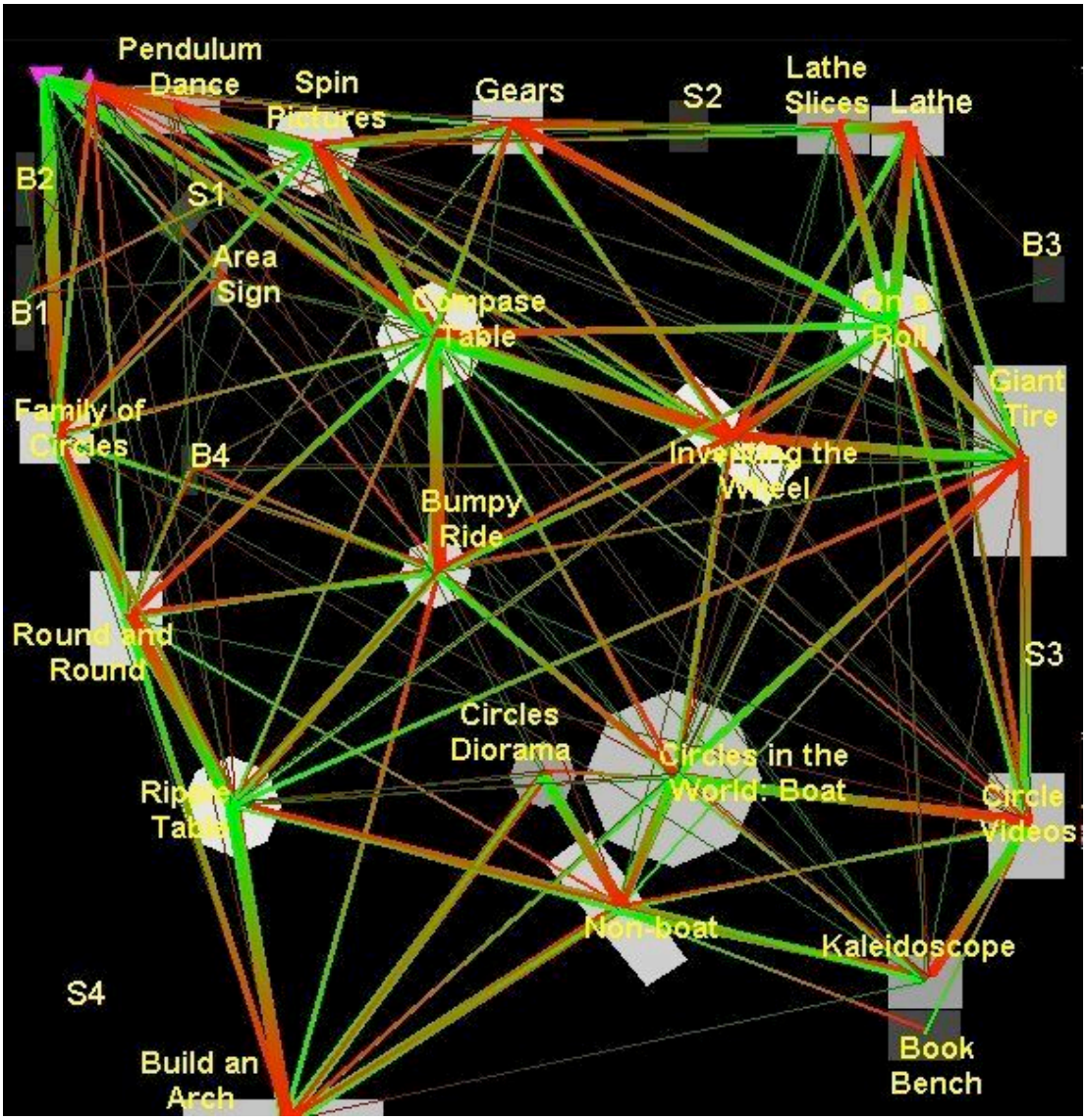
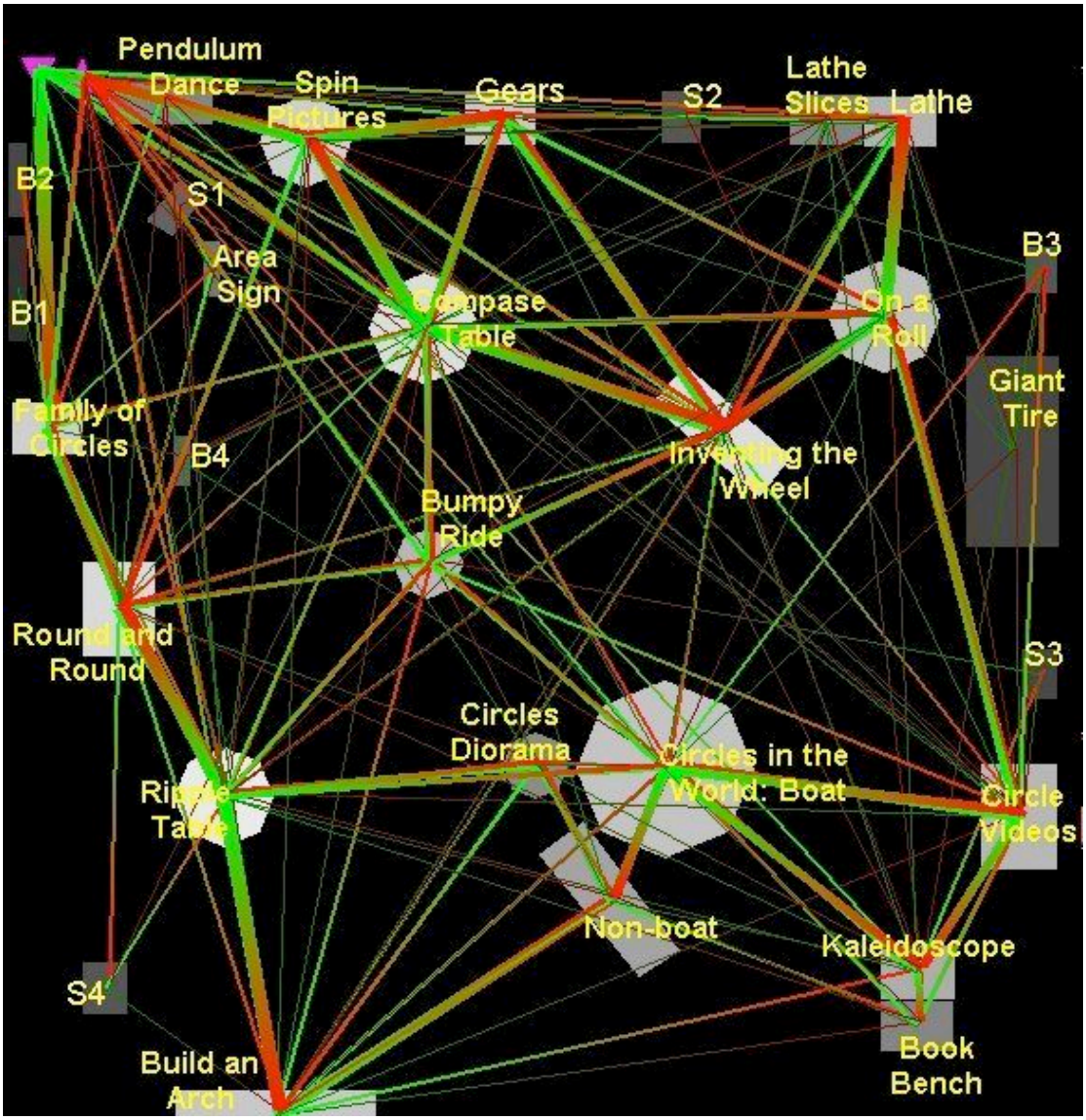
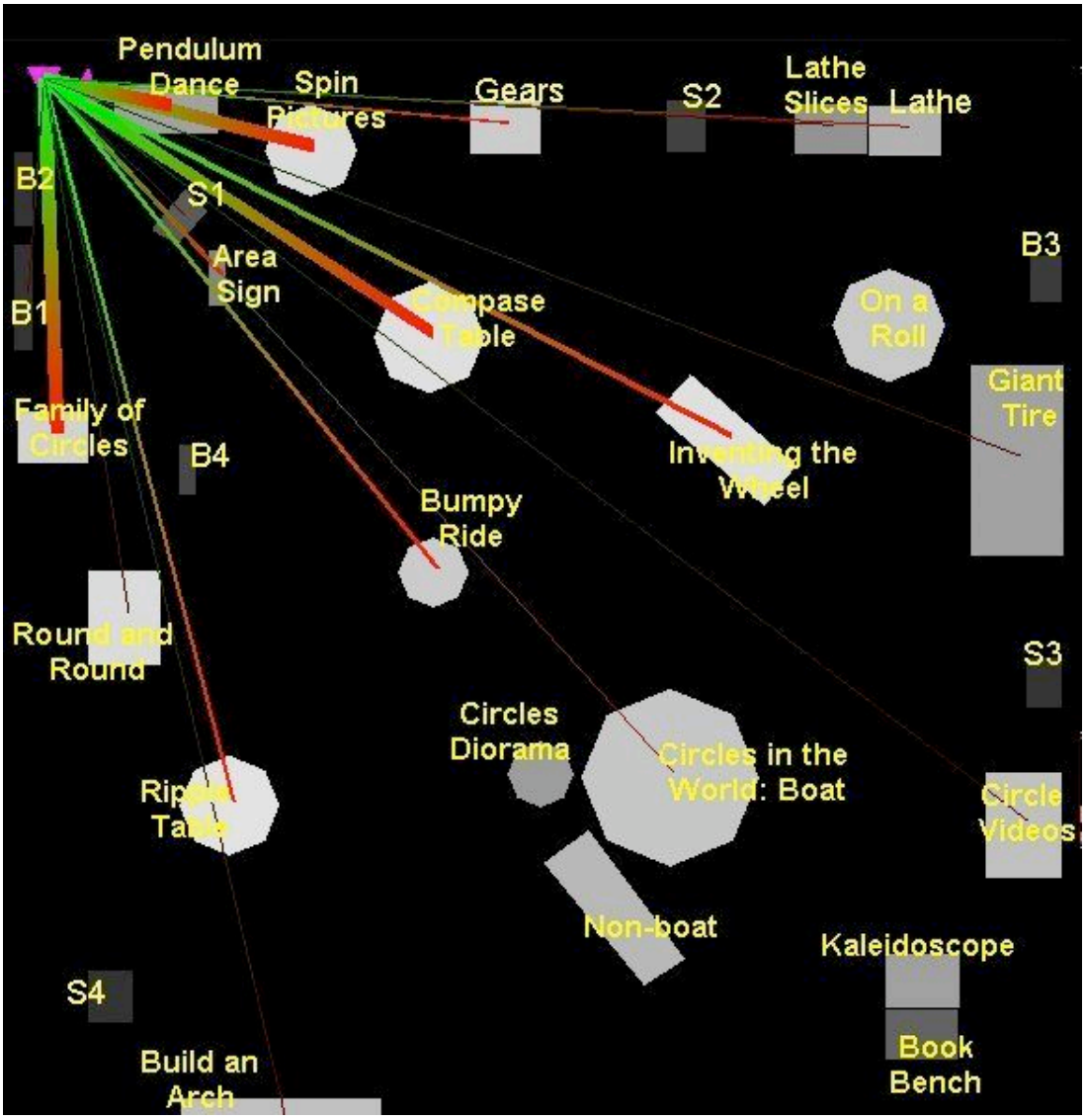


Figure 11: Movement Map for adults (N=37)



Finally, the two Movement Maps below show the data for visitors entering and exiting the exhibition: the first and last elements visited.

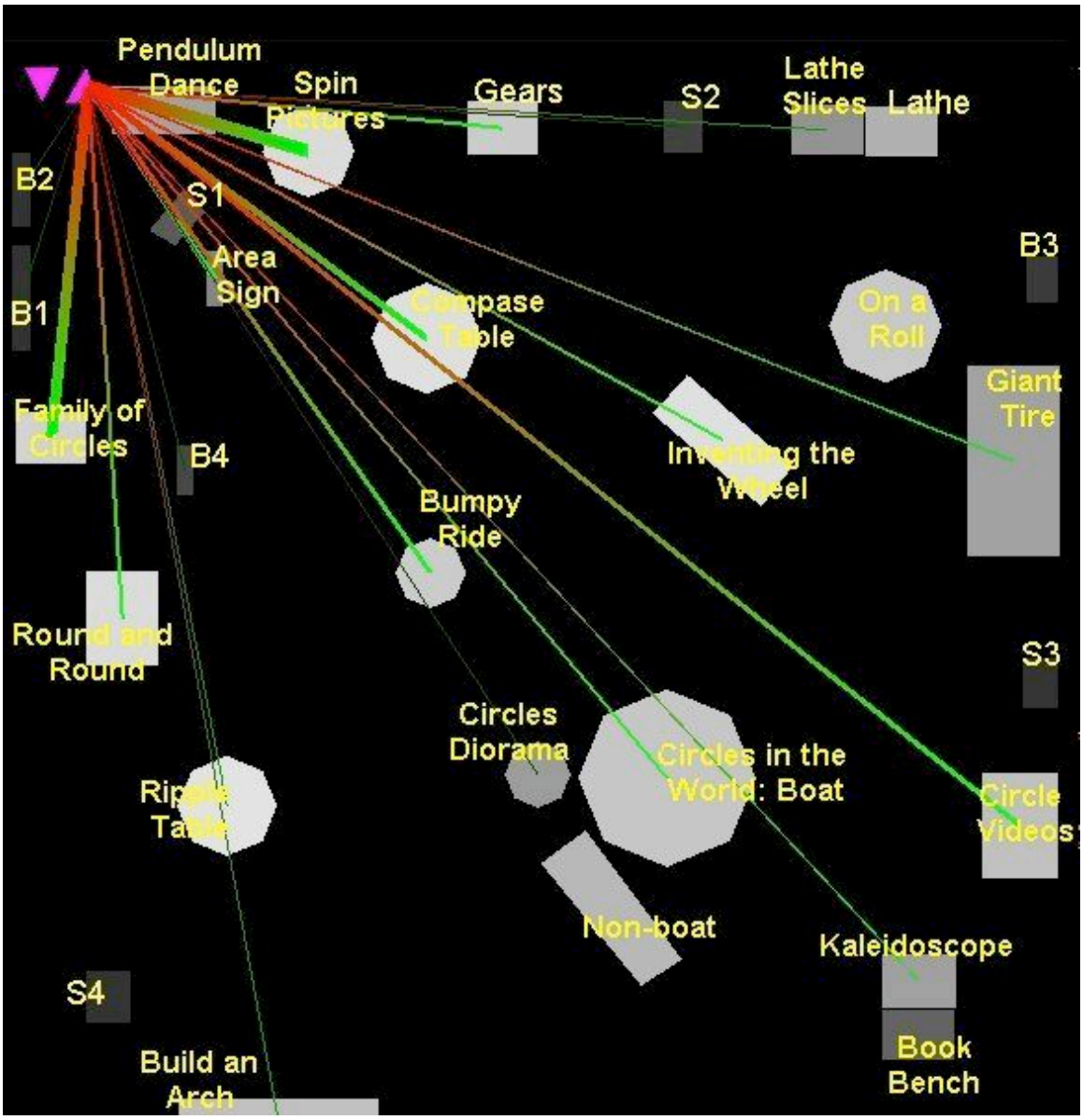
Figure 12: First movements of all visitors entering exhibition (N=113)



With its spray of short segments, this map supports the pattern of visitor behavior noted previously:

(i) Visitors entering the exhibition make a range of choices about what to visit first.
(ii) The most popular choices are interactive exhibits.
(iii) Most visitors stop at nearby exhibits; after entering, they become quickly engaged by an exhibit element near the door and do not penetrate the exhibition deeply at first.

Figure 13: Final movements of all visitors exiting exhibition (N=113)



The first-entry and last-exit maps are fairly symmetrical, showing that the range of choices visitors make when first entering are roughly mirrored by the paths of exit. Perhaps the most notable exception is the substantial segment from the Circle Videos to the exit that was not mirrored in the entry paths. This element was not as attractive as many of other exhibits, but it had the longest holding time, so it seems likely that once

they discovered it, some of its users were caught up with it until the moment their groups left the exhibition and pulled them away.[17]

f) What kinds of behaviors did visitors display in the exhibition?

(i) Behaviors at exhibits

The following behaviors were noted at the 20 exhibits in the exhibition (i.e., elements that were not benches or large-format signs):

Sitting:
Circle Videos was the only exhibit at which more than half of visitors sat down (54%), reflecting the fact that this was the exhibit (excluding benches) which had the longest holding time in the collection. About one third of the visitors sat down at Gears, Kaleidoscope, Lathe, Spin Pictures, and Book Bench, all of which provided seating as part of the exhibit element.

Calling over:
Typically, about 5-10% of visitors called someone else over to join them at any individual exhibit.

Pointing:
Unsurprisingly, the element that evoked most pointing (11%) was Circles Diorama, where the central activity was identification of circles and the objects of interest were behind a transparent window. Pointing rates of 5-10% were also observed at Arch Bridge, Spin Pictures, and Circle Videos.

Taking a photo:
Photography was essentially limited to two element Circles in the World: Boat, in which adults typically photographed their children dressed up and sitting inside the round boat, and Arch Bridge, at which adults captured their children walking on the complete structure. These had photography rates of 8% and 7% respectively.

Interacting physically:
Levels of physical interaction were very high for all elements that supported it. The average interactivity rate across all interactive exhibits was 84%; in other words, if a visitor stopped at an interactive exhibit, there was an 84% chance that he/she would physically interact with it. The rates for children were extremely high (91%), but even adults interacted at 70% of the exhibits where they stopped, indicating they were participating actively as well as observing their children. Unsurprisingly, the lowest level of interactivity observed was for the Book Bench: only 50% of visitors who stopped interacted with one of the books.

[17] On reading a draft of this report, the observer confirmed that this was something he saw many times.

Reading labels out loud:
Reading out loud was very rare. The exhibit label for On a Roll was read out loud by 4 visitors: because this exhibit was very open-ended, visitors may have wished for more guidance on what to do there, or alternatively, they may have wanted to understand more about the intriguing behavior of the rolling disks. At Family of Circles one girl read out loud from the multi-page "in-depth graphic" (an example of which is shown in Appendix B). Three other exhibit labels (not in-depth graphics) were read out loud once only.

Reading or perusing labels silently:
Because the small amounts of text on the large-format signs and simpler labels could be read while moving, we were only able to observe silent reading behavior at the more extensive multi-page "in-depth graphics" that served as labels for many of the interactive exhibits. Levels of silent reading (or looking intently) in the 0-10% range were observed at the in-depth graphic of almost every exhibit. However, three were read more often: Build an Arch (19%), Inventing the Wheel (14%), and Kaleidoscope (14%). [18]

Being accompanied:
Observed visitors were typically accompanied by someone else when they stopped at exhibits. Specifically, visitors were accompanied 79% of the time at exhibits they stopped at, with accompaniment defined as any other visitor being engaged at the same element at the same time, or taking clear steps to move towards it and stopping within 10 feet of it. The younger children (3-5) in our sample were accompanied at 87% of their exhibit stops; 6-10 year olds at 73%, and adults at an intermediate rate of 82%. These numbers include cases where strangers were using an exhibit at the same time as the observed person, so they do not necessarily imply that family members stayed close to each other; nevertheless, they suggest that exhibit interactions were mostly social experiences rather than isolated ones. Only two exhibits had accompaniment levels lower than 60%: Lathe Slices (58%) and Book Bench (50%). In the case of Lathe Slices, the solo visitors were mostly children, perhaps waiting to use the neighboring Lathe and finding something to occupy them in the meanwhile. In the case of Book Bench, the solo visitors were mostly adults and older children; presumably they saw reading as a relatively solitary activity.

Talking with an adult:
Overall, the observed rate of the tracked visitor talking with an adult while at an exhibit was 60%. For children aged 3-5, the rate was highest (77%), for children aged 6-10 it was 62%,

[18] It is worth noting here that it is notoriously difficult to accurately determine how much use visitors make of labels. Reading levels in this study seemed rather low when compared with studies of visitors quoting or paraphrasing from labels, but in this study there was no recording of conversations, so direct comparisons cannot be made. One of the ironies of observing reading behavior in museums is that labels such as those in *Secrets of Circles,* that are well-placed near visitors' natural focus of attention, short enough to read quickly, and phrased in a conversational tone, are more likely to be read by visitors than long labels placed off to the side of an experience, and yet these same qualities make them more difficult to be observed being read. Visitors self-reported high levels of have read at least some of the labels (82%), though this number may be subject to a pleasing-bias.

and for adults it dropped to 42%. Clearly then, it was children who talked most to adults while at exhibits. This is not surprising, and may reflect the tendency of parents to be primary mediators of children's experiences, as well as the fact that there were many family groups that had only one adult.

Talking with a child:
In the expected reverse pattern to the previous category, young children talked least to other children (21%), older children talked slightly more often (27%), and adults talked most often (66%). Again, this probably reflects a confounding of a dominant parent-child conversational pattern with the fact that a multigenerational family in the sample would have to have at least 3 members for this kind of talking to be possible within their own family group.

Physically using an exhibit alongside an adult:
Overall, 45% of people who stopped at an exhibit used it physically while alongside (or took turns with) an adult. As expected, the rate was highest for young children (64%), lower for older children (47%) and lowest for adults (23%). This pattern matches that of talking with an adult. The exhibit with the highest levels of use alongside an adult was Compass Table. This may reflect high levels of participation by adults (many of whom revealed in interview data revealed their familiarity with compasses from their school days), or may simply reflect the fact that this was a large and popular exhibit which was subdivided into several smaller activities that could be used by several families at once.

Physically using an exhibit alongside a child:
Overall, 49% of people who stopped at an exhibit used it physically while alongside (or took turns with) a child. This rate was fairly constant across age groups: 3-5 year olds (45%), 6-10 year olds (51%), and adults (50%). Once again, the exhibit that scored highest in this behavior was Compass Table (82%). It is interesting that, of the last four behaviors listed, this is the only one that did not show significant variation by age. The results suggest that children were more likely to use exhibits with each other than to talk with each other.

(ii) Behaviors at large-format signs and benches

The following behaviors were noted at the non-exhibit elements in the exhibition: four benches, four large-format signs, and one introductory sign with a hole cut in it:

Sitting:
Unsurprisingly, no visitor sat down at a large-format sign. Visitors did sit on benches, but not always: a small number of adults and children talked to other sitting on benches without sitting themselves. These numbers were too small to warrant further analysis.

Calling over, Pointing, Taking a Photo, Reading aloud or silently:
No visitors were observed to do any of these behaviors at a large-format sign or bench.

Interacting physically:
The only element that supported interactivity was a sign that introduced the exhibition at the front of the gallery. Because this sign had a circular hole it in near the ground, it was possible for a person to crawl through it. In fact, fully 75% of the 24 visitors who stopped at this element did crawl through it: 11 boys, 5 girls, and 2 adult men! A typical interaction was as follows: a child would run to the sign, then run through the hole once, twice, or sometimes more, laughing or sometimes chased by another child. Younger children were often helped through by a parent who held their hand, but the children were invariably the ones initially engaged by the exhibit.

Being accompanied:
Across all large-format signs and benches, people were accompanied 71% of the time. However, the numbers are mostly too small to say anything about this figure; the only element with significant numbers of stops in the first place was the Area Sign with the crawl-through hole: it had a 75% rate of accompaniment (18 of the 24 people who stopped there).

Talking and using with others:
Talking with others at the interactive sign was observed in about a third of the cases where a visitor stopped there; using the sign alongside others was rare, presumably because only one person could pass through the hole at a time. At all other elements the numbers of stoppers was too small to draw any conclusions.

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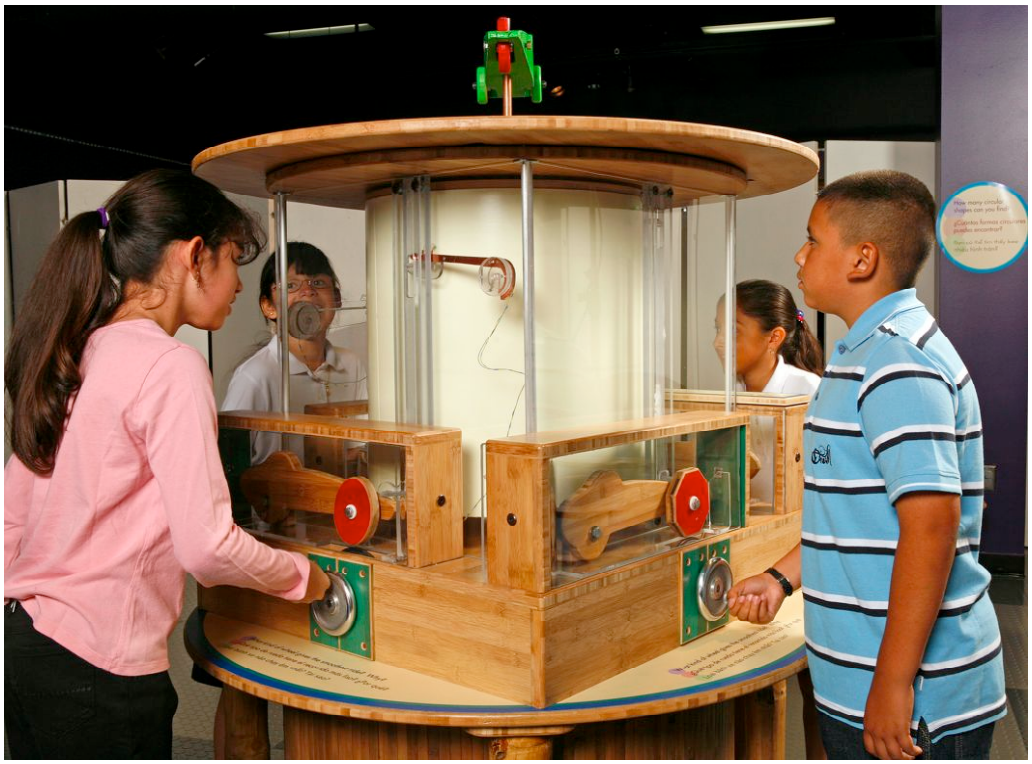


Exit Interview Study with Adults

Purpose

An exit interview study was conducted with 107 adults from the regular weekend audience, to determine how they responded to the *Secrets of Circles* exhibition.

The main research questions for this study were:

a) *What kinds of responses did adults from CDM's general family audience have to the exhibition?*
b) *Did adults recognize the main theme of the exhibition?*
c) *Did adults appreciate some of the unique properties of circles?*
d) *Did adults make connections between the exhibition and their own lives?*
e) *How did adults respond to the design (look and feel) of the exhibition?*
f) *How did adults respond to the trilingual labels?*
g) *Were any of these responses different for parents of different ages, language groups, or other demographic characteristics?*

Methods

A total of 107 adults from multigenerational family groups were interviewed during four weekend days and one holiday between November 19 and December 27, 2006.

Adults were recruited just prior to their exiting the gallery in which *Secrets of Circles* was located. Adults were eligible for recruitment if they were observed to be in a group with at least one member of the targeted audience (3-10 year olds). In each case, the next eligible adult to cross an imaginary line near the exhibition exit was approached. Adults within a family were allowed to decide among themselves who would do the interview. This flexibility was introduced because pilot testing showed that adults were often under some stress as they followed the children in their group and met their needs, and adults in multi-adult groups often suggested a strategic plan about who could stay and do an interview and who should follow the children elsewhere in the museum. The method sacrificed a degree of randomness in the sample for a higher participation rate.

The refusal rate was 40%. The four most common reasons for refusal (when given) were:

- Following the needs or wishes of the child(ren) in their group, including needs to eat, go to the bathroom, or pulling them in a different direction (24% of all refusals);
- Having too little time (18%);
- The adult not feeling fluent enough in English to want to do the interview (10%);
- The adult not feeling familiar enough with the exhibition to be interviewed (10%).

Adults who agreed to participate were invited to sit on a bench just outside the exhibition (where they could not see it). If an adult said they needed to follow their children, they were accompanied until the interview was complete, sometimes standing or walking as necessary.

All interviews were conducted by fully bilingual interviewers in Spanish or English, according to the preference of the interviewee. Spanish interviews were later translated by the interviewers into English, for further analysis. Findings and interpretations were reviewed by one of the interviewers and also an independent evaluator who specializes in Latino audiences, to check the reasonableness of the conclusions and correct any obvious misinterpretations of the data.

For a complete list of interview questions, see Appendix D.

Exit Interview Participants

Table 8 presents some of the demographic and background information of the 107 adult visitors who participated in the interview.

Table 8: Adults who participated in exit interviews

Demographic / background factor	Categories	(N=107)
Gender	Female	56%
	Male	44%
Age	18-25	2%
	26-35	36%
	36-45	50%
	46-55	9%
	56+	3%
Region currently lived in	San Jose	28%
	Santa Clara County (excl. San Jose)	23%
	Santa Cruz County	3%
	North Bay	17%
	East Bay	13%
	Central California	5%
	Northern California	5%
	Southern California	2%
	Outside California	4%
	Unknown	1%

Demographic / background factor	Categories	(N=107)
Group size	2	21%
	3	24%
	4	30%
	5	11%
	6	8%
	7+	6%
Children in group	Includes age 3-5	69%
	Includes age 6-10	32%
	No children 3-10 (i.e., no members of target audience)	20%
Language spoken at home*	Target languages:	
	English	77%
	English only	58%
	Spanish	8%
	Vietnamese	4%
	Chinese / Mandarin / Cantonese	13%
	Other Asian languages	7%
	All languages not listed above	8%
Ethnic origin / nationality (open-ended question, verbatim responses)*	White / Caucasian	30%
	(Specific Asian country excl. Vietnam)	24%
	American	21%
	Asian	11%
	European	8%
	(Specific non-Asian country)	6%
	Mexican	4%
	Vietnamese	3%
	Hispanic	2%
	Latino	0%
	(All other self-identifications)	<2% each
Visited museum before	Had visited before	70%
	First visit	30%
Seen exhibition before	Had seen *Secrets of Circles* before	30%
	First time seeing *Secrets of Circles*	70%
Member	Member	50%
	Non-member	50%

* These numbers may add to more than 100% because of families who gave multiple answers.

Summary of Findings

Most adults were enthusiastic about the *Secrets of Circles* exhibition, appreciating the theme, the closed off gallery, the colorful and natural design, and the accessible interactive experiences. About one third offered suggestions for improvements: including more elements for younger children, more detailed explanations in labels, and even more interactive exhibits.

Fully 85% of adults recognized that the theme of the exhibition was Circles. They talked about the properties of circles, their uses, ubiquity in daily life, how they can move or spin, and how to make them. Adults resonated most with the Circles Secrets that had to do with the usefulness of circles and their prominent role in daily life. Secrets that involved symmetry, smoothness, or trajectories, were rarely articulated, though visitors did understand the implications of these notions, such as: a curved bridge is strong, or a spinning wheel runs smoothly. Most adults (61%) reported making connections between objects or ideas in the exhibition and something from their own lives.

Adults found the trilingual labels understandable and easy to use. Overall, 86% said they would recommend that future labels be in other languages as well as English. Visitors who spoke Spanish as their home language were especially supportive of the labels. Interestingly, the labels appeared to play a key role in promoting understanding: Visitors whose home language was English, Spanish, or Vietnamese were more likely to recognize the Circles theme than those whose home language was not in the labels.

Detailed Findings

a) *What kinds of responses did adults from CDM's general family audience have to the exhibition?*

Overall, adults were enthusiastic in their responses to the exhibition. When asked what they would like to share about their experience in the exhibition, 63% of respondents spoke about their enjoyment and appreciation of the exhibition. For example:

> It was great!
> I enjoyed it immensely.
> I really liked the room.
> I liked this exhibit more then other ones I've seen in there.
> I think it was a great, fantastic idea. It would be nice to see other shapes too. After seeing the circle exhibit I want to join here as employment!
> I thought it was fun, it was educational.
> Interesting, good.
> It was neat.
> It's cool!
> It's nice, it's a well rounded room, get it?
> The kids had fun.
> Kids spent more time in this room then anywhere else in the museum.

The kids really enjoyed it, we spent lots of time in there.
Really enjoyed it.
This is our second visit, and we still enjoy it.
Very interesting exhibit.
This exhibit is way better than the rest of the museum.

Of those who gave comments, 18% gave specific aspects of the exhibition they particularly enjoyed or appreciated:

It really impressed me, reading about building with circles.
I think it's great; it is a closed space and that kids can stay at stations for a long time.
I liked that the room was closed off so that kids were all in the same general area.
It's really nice that that room evolves and changes. I really like to go in there and see what's new.
It was really fun. The different things like motion and light were really great.
I enjoyed that it was quieter, closed.
Enjoyed it a lot, love that it rotates, it is nice to have fresh, new things.
One of the reasons we keep visiting the museum is because you have new exhibits it's fun and interactive for the kids.
I love that everything was so self-explanatory, even for 4-year olds
Keep it up! I loved that the stuff is sturdy and made to last.
I really appreciated it, I feel more balanced. Circles are my favorite shape, I liked this exhibit more then other ones I've seen in there.

Finally, 37% of the respondents shared criticisms or suggestions for improvements:

regarding the lack of things for younger children:

It should be for all ages.
It's not really geared for younger kids.
The age range should be wider, for younger kids.
Seemed too old, maybe there should be a sign saying it is for 4-year olds and older, that would be nice.
It's too quiet, and it's not attractive to little kids, would be better with exhibits for more ages.

about the labels and signs:

The signs should have more explanation. It's hard as a parent for me to explain to my kids the differences between pulling something flat and round; what are the concepts beneath that? For a 7-year old kid, she needs that kind of explanation.
It was entertaining for kids, but there was a lack of instructions, so more directions would be nice.
I thought the explanations were not enough; I would have liked more on why the things were happening.

There's not much order, it's all random. I have a 4-year old with short attention span, and it's hard to read them. The instructions aren't clear, you need something easier.
I would love to see Chinese on signs and labels.

requesting even more activities:

Circles are fun. There are a lot of creative displays, but there could be more; maybe it's just starting off.
More activities about circles. When you have volunteers helping out, it helps children learn more.
I think there's an exhibit missing, they should have more things in there to keep kids interested.
I 'd like to have more hand-on experiences, something that kids can get their hands dirty and experiencing with.
Keep expanding it. Oh wait! include pi, as in 3.14, because pi is important to circles. I thought that was missing.

about miscellaneous issues:

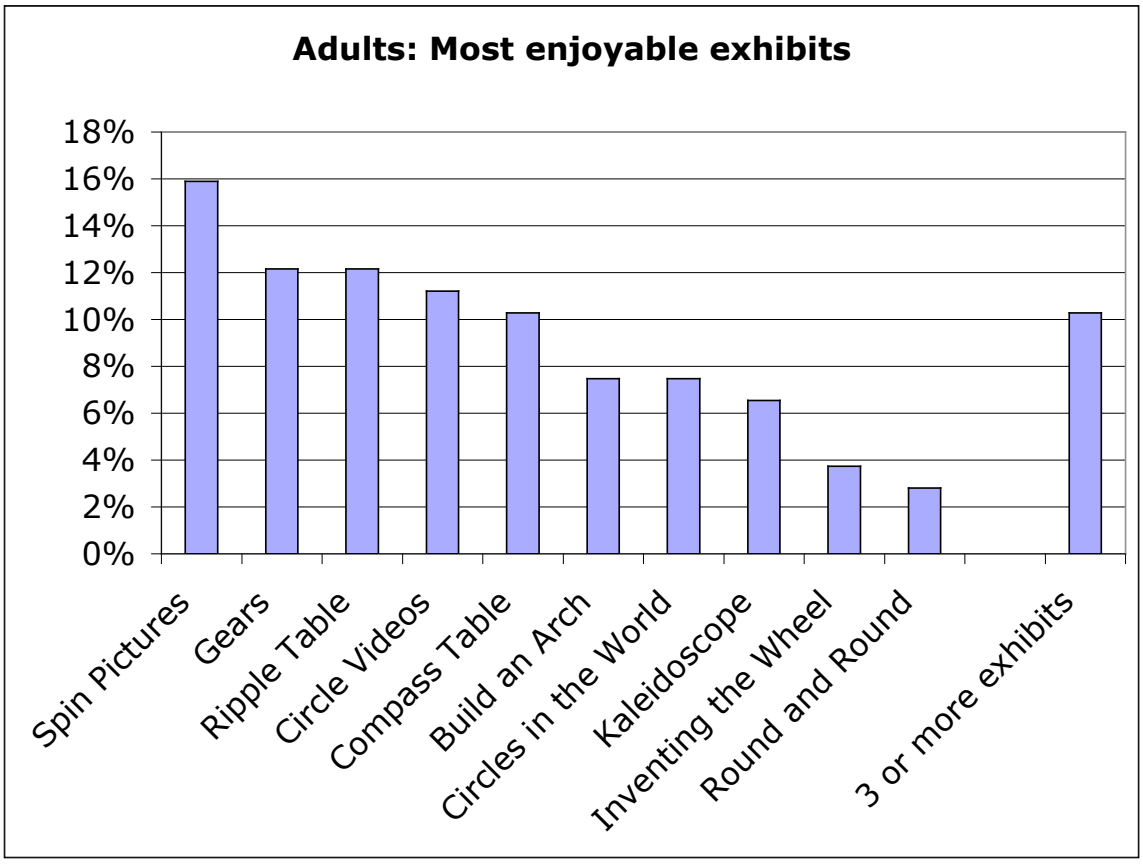
I wasn't too impressed with the donor screen and exhibit entrance
A couple of things are not working, it would be nice if they were.
Some of the exhibits are not working.
Jazz it up, I guess.
Maybe add some music in there it was kind of quiet.

and finally, about making the exhibition easier to find:

It's hard to find, it's too hidden.
It's a great exhibit, should be better advertised because we just stumbled on it.

Adult visitors were also asked whether the exhibition contained anything they particularly liked or enjoyed. In response to this question, most people named specific exhibits. The most frequently mentioned exhibits are shown in Figure 14.

Figure 14: Exhibits that adults said they particularly enjoyed



Occasionally visitors justified their choice of favorite; some of these are listed below:

Gears:

The gears, because they're an interactive exhibit, and easy to explain to my kids.

The gears, because my kids can group them, rearrange them, they enjoy doing it.

Ripple Table:

Ripple Table and Build an Arch, because my kid can do something with them.

Ripple Table, On a Roll, and Circle Videos, because we can think about how to arrange the objects to make different pictures scientifically.

Circles in the World:

Overall it was too old for my son – he's 2 1/2, so we liked the boat the most.

Build an Arch:

He enjoyed the arch -building it and destroying it and then building it and destroying it again.

The bridge, it was interesting. I'd just read a book with my son about building bridges. More instructions for parents would help, though, step by step detailed instructions.

Bumpy Ride:

Bumpy Ride, more like my job, it was too much for my daughter.
The one with the bumpy road- it reminded me of a science experiment.

Round and Round:

Liked seeing the kids interact with circles and lights, they were very interested.

In addition, 9% of the visitors said they particularly enjoyed three or more exhibits, or the entire collection:

The room, all the activities.
I liked everything.
The whole setup. I loved that it's hands on – I got ideas for my classroom [a teacher].

b) Did adults recognize the main theme of the exhibition?

Adult visitors were asked whether they recognized any common idea or theme in the gallery.

Fully 85% of adults correctly identified Circles as the exhibition theme. Visitors who said simply "circles" were asked to elaborate further. They mentioned the following themes[19], all of which were compatible with the core messages of the exhibition:

How circles can be useful, or how they work(20%)

Circles, how they work, and how they're used.
Circles, how they are used in real life.
Circles, the different ways to explore circles, the technology.
How circles are used around the world, engineering, how they facilitate stuff
Variety of ways that wheels are used in science and tool making, and everything is not always as you perceive it.

The ubiquity of circles in daily life (12%)

Circles, that they are part of our lives.
Circles, that circles are very common.
The overview of circles, how they appear in daily life.
Yes, circles everywhere.
Circles are important. They appear in many things in real life, so many things that we don't even notice them.

[19] These themes are not mutually exclusive, and some responses fit several of the categories.

Motion of circles (11%)

Circles, rotation and lights
Circles, movement
Circles, spinning, circles help you get other shapes.
Circles, the geometry, circular motion
Circles, it made it easier for moving objects.
How circles play a part in everything in motion.

Properties of circles (9%)

Circles, symmetrical properties, the property of circles and what happens when they spin.
They're strong and efficient, good for building.
Circles, well, they're round.
Circles, that they're colorful.
Circles, their usefulness, durability and strength.

How to make circles (7%)

Helped me understand different ways circles are made, something like that.
Circles, like how to make them.
Circles, they make different circles, and designs.
Circles, making circles, spinning, power, strength.

A few of the visitors who recognized the circles theme also saw other themes, including "lights," "culture," and "Asian theme."

Only 15% of visitors did not mention circles or wheels in their answer. Of these, 4% recognized other themes:

Mostly green.
Technology.
Gets kids to start thinking in scientific, hands-on way. Helps facilitate thinking.
It had a bamboo Asian feel.

Finally, 11% did not notice any common theme in the exhibition.

Interestingly, the percentage of adult visitors who correctly identified Circles as the exhibition theme did not depend on gender or repeat visitation, but did depend on home language. Specifically, 91% of visitors whose home language was represented in the labels (English, Spanish, and/or Vietnamese) correctly identified the Circles theme, whereas only 62% of visitors with home languages not represented in the labels did so. ($chisq(1)=11.0$, $p<0.001$). This is an important finding, and shows that the main theme of the exhibition relied, at least in part, on labels for its effective communication. Also, speakers of un-represented languages did not report a difference in their frequency of reading of the labels, so if all visitors were

honest in reporting their use, this suggests that success in communicating the exhibition theme may depend not just on use, but on comfort or fluency with the label language(s) selected. This is further supported by the fact that the difference is still statistically significant if one looks only at the subset of visitors who said they read labels: Of 88 visitors who said they read (at least some) labels, 90% of those whose home language was English, Spanish, or Vietnamese correctly identified the theme, but only 65% of those whose home language was not represented (chisq(1)=7.0, p<0.01).

c) Did adults appreciate some of the unique properties of circles?

Visitors were asked whether they had noticed anything in the exhibition that had a circular shape that helped it function well, and to explain how the circular shape helped it.

Table 9: Adults' identification of exhibits with circles as a functional shape

Exhibit	(N=107)	Example of underlying reason given
Inventing the Wheel	24%	The wheel on the carriage [blocks]. it makes the resistance low by decreasing the friction.
Gears	9%	Cranking the gears, circles move together.
Build an Arch	8%	Yes, the bridge: the circle shape makes it easier to cross and it's stronger.
Compass Table	6%	(none)
Bumpy Ride	5%	Seeing the little car they understood the round circle, it made it easier.
Round and Round	5%	The spinning light wheel: an oval or square wouldn't be quite as easy to spin, it wouldn't work.
Lathe	3%	(none)
Circles in the World	3%	(none)
Family of Circles	2%	It needed to be a circle in order to spin.
Ripple Table	2%	(none)
Giant tire	2%	The tire thing: you couldn't spin it if it wasn't a circle.
Circle Videos	1%	The videos spin and show things.
Spin Pictures	1%	The camera had hidden circles that could be seen

Exhibit	(N=107)	Example of underlying reason given
		when it was spun.
Circles Diorama	1%	(none)
Exhibits with wheels	12%	Sure, wheels: they run smoother.
Nothing identified	30%	

Overall, 70% of adults named something in the exhibition that had a circular shape they felt contributed to its function. Impressively, almost every interactive exhibit was mentioned at least once (14 out of 17). The most common example, mentioned by 24% of the group, was Inventing the Wheel, in which visitors experience the difference between pulling a heavy sled with and without wheels attached.

Most visitors could identify an exhibit with a functional circle in it, but they had a much more difficult time explaining how the circular shape helped it. Only 21% of visitors gave some kind of explanation, and many of these tended toward the descriptive or tautological. Some of the most explanatory statements are given in Table 9.

In another question, visitors were asked whether they had realized or been reminded of anything about circles while they were using the exhibition. Only21% gave some kind of properties or principles related to circles, possibly because the wording of the question was ambiguous. Of those who did talk about circles in general, most gave statements of heightened awareness and appreciation for circles:

> We can't live without them.
> They are awesome.
> That they are a part of everyday life.
> All of the circles around.
> Seems like they are all around, in nature and in everyday life.
> Circles can be useful.
> Yes, circles, it was mostly about circles rotating and making circles.
> The spheres, it reminded me of how many things are made of circles.
> I was reminded how you can make them work for different things.
> We do use them in real life. It's good in a sense that my kids can experience them here, and they hardly see them outside, like the basket [round boat].
> That circles have been around since ancient times, with different structures - like the Vietnamese boat. They are nothing new.
> Reminded me of a song my daughter sings that talks about how circles are everywhere. And made me think of who invented the circle.

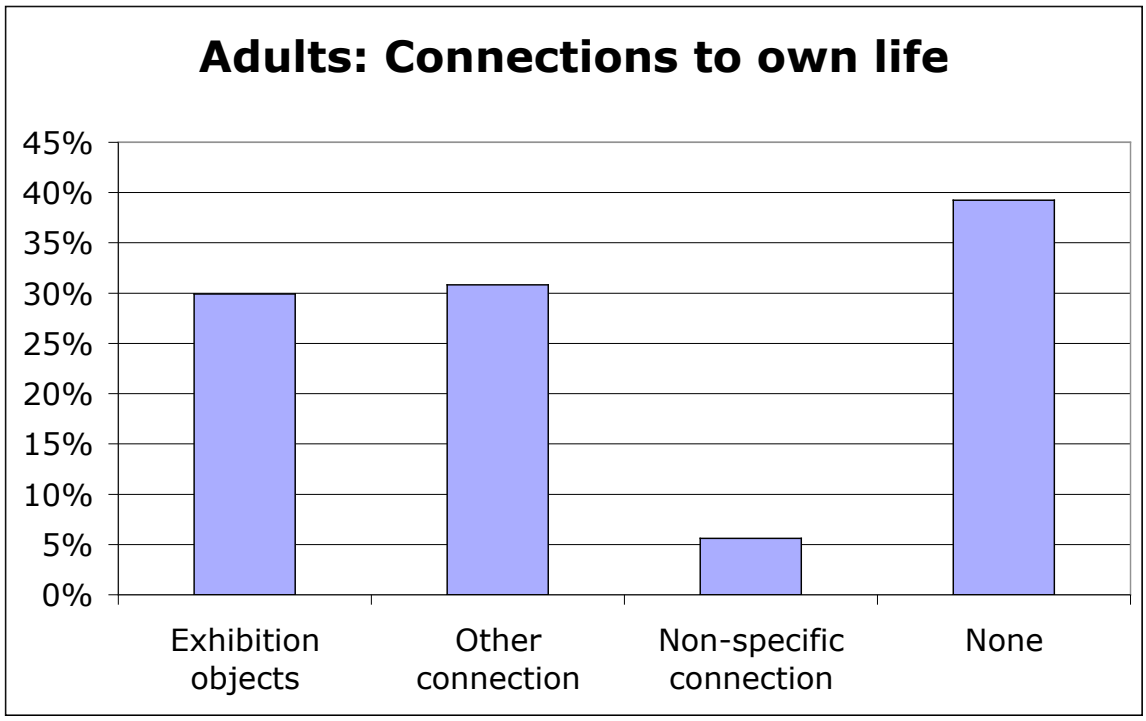
and only a few were properties or principles:

> They're round.
> Yes, single points make a circle.
> The 3-d aspects of it.
> The centrifical [unclear whether "centripetal" or "centrifugal"] force of the big tire.
> The efficiency [of circles].
> How they make things work easier.
> Rolling makes it easier to move things around.

d) <u>Did adults make connections between the exhibition and their own lives?</u>

Visitors were asked whether they had made any connections between the exhibition and their daily lives. The results are summarized in Figure 15.

Figure 15: Types of connections adults made to their own lives



In total, 61% of the visitors interviewed said that they had made a connection to their own lives:

> **For 31% of visitors, the exhibition reminded them of specific objects in their daily lives.** These connections showed great variety: books, compasses, bridges, cars, bike

gears, lathe, food, magnets, bugs, fruit, hats pulleys, pottery, wheels, balls, carts, mirrors, pictures, Spirograph, tires, kaleidoscope, and carvings. For example:

Compasses I used a lot in high school, and the gears on my bicycle.
Just the book, that I had read to my son.
The bridge, I go over bridges a lot.
Everything, the gears in my car, wheels, circular.
The cars, lathing tool.
Domes, buildings, bridges, food - the fruit.
Fireworks, they're neat.
Food and magnets and bugs.
Probably the bowl of fruit, I love fruit.
The Vietnamese exhibit, the hats.
The mirrors, and also in my country I had this [gestures using a kaleidoscope]
Yes the pictures.
The pottery.
Yes, pulleys.
The snapping pictures, the Spirograph.
It had a lot of practical things: the tire, the food.
We see tires, wheels everywhere in real life. We see compasses in schools; they are regular math instruments.

29% of visitors made connections that went beyond recognition of familiar concrete objects, to broader ideas, activities, metaphors, or memories of previous times in their lives. For example;

How things work, how technology works.
Math, the exhibit was coordinated a lot with math.
They reminded me of Physics lab. The video reflects light, how the spectrum works, and it's an advanced form of a kaleidoscope.
My engineering classes at San Jose state, the gears.
The lathe reminded me of a carpenter class I took in school.
Yeah, the big tire because I grew up in a farm.
I remembered what I had studied in high school with compasses.
The compass reminded me of school and math. Reminded me of childhood play, like playing with a top.
The tire, we used to roll down the tire all the time, we went very fast.
The boat, growing up on the shore. And the pond reminded me of my class putting in the pond out back.
Yes, the game on the video reminded me of my country.
Bamboo furniture reminds me of China, and Asian culture, and math concepts, and pictures.
My husband and son are artists, so I was reminded of that in the parts where you draw the circles, take video, turn the wood. That's interesting.

It reminded me of playing as a child, and seeing it as an adult looking at it on another level, it reminded me of my job as a teacher.
I was reminded that I love to play with stuff.
I'm at the end of the circle of life and she [girl] is at the beginning.

7% of visitors said they had made connections with the exhibition in a general way, but did not provide details:

I'm a math teacher, so … all over the place.
Everything, but I wasn't really thinking of it.
Sure everyday, nothing in particular.
I didn't think about that…things you have at home.
Some, seeing circles in everyday life.
Not really, well everything.
Everything in your life has circles, it's everyday living.

The remaining 39% of adults said they had not made any connections between the exhibition and their own lives.

e) How did adults respond to the design (look and feel) of the exhibition?

Visitors were asked whether they had noticed anything about the design of the exhibition, including the colors, materials, or the look of the furniture and signs.

While this was a leading question in the sense that visitors were encouraged to remember specific aspects of the exhibition, it is striking how much visitors did remember, especially given that they were interviewed after they had left the exhibition and could no longer see it.

Fully 67% of visitors had specific responses to the design of the exhibition.

Almost a third of visitors, 30%, commented on the exhibition's colors. Most people found them pleasantly bright, while a few described them as neutral or dark. Visitors particularly remembered purples and greens. For example:

It was nice and bright.
It's color-coordinated.
Kid-friendly, colorful, a lot of purple.
I just noticed all the green, mostly green stuff.
I noticed the patterns, the greens and purples, also the bamboo.
The green and purples.
Yeah, all about the neon colors, ultra, uh, neat, the kids liked it.
The black light look.
Colors are very soft…
Really colorful, comfortable, warm colors…

Colors are very soft…
Seemed real neutral and put together, not exciting enough for my son, he's little.
Lots of wood, on the darker side, not bright.
Very Asian-themed, brown/black coloring.

A number of visitors (21%) noticed the materials in the exhibition, particularly the wood and bamboo. Some recognized the theme as Asian or even Vietnamese, and several even used the word "natural," exactly matching the terminology of the team's designer.

All bamboo or wood-related.
Bamboo, it was like the Vietnamese exhibit [presumably *Dragons and Fairies*]. I thought they used bamboo because it's round too.
The floor, rubbery matting stuff.
Natural focus with bamboo, circular, lots of greens and purples.
I like the natural, the wood.
Lots of wood, on the darker side, not bright.
I like that there is a lot of wood, very comfortable. It balances with high tech things, and shows that circles are also in nature.
Asian theme, wood.
Vietnamese, lots of wood.
A lot of bamboo furniture, which I like, I wonder where they got it. It was Vietnamese, seemed like it was Vietnamese-themed.
Seemed to have an Asian theme: the hats, woven boat, fabric patterns, etc.

Visitors also commented on the open layout and good traffic flow, the quiet atmosphere, available seating, kid-friendly exhibit heights, and overall comfortable feel:

...I like that the museum provides seating for parents.
The room is set up to have a nice flow.
It's a nice, new room.
Nice and open [layout].
It's quieter than the other rooms.
Everything's very good, excellent: materials are reachable to kids, colors are attractive, furniture looks good. Kids are able to touch and enjoy.
...I liked that everything was lower to the ground for kids, didn't have to be there to help them with activities.
Very simple, I liked it, not much distraction, it was nice.
It was soothing.
It's nice, inviting, comfy.

Finally, several visitors recalled that the shape of elements in the room (furniture, flow, or the room itself) had a circular shape that was appropriate to the exhibition.

Everything is circular.
They're all circle-shaped and round.
Everything is a circle, except the benches.

Bamboo, and that cross-section is a circle and there were lots of them – it was very appropriate.
The room was wooden and it had round edges.
The design of the room makes you go in circles.

While the majority of comments about the design were positive, visitors also raised a few specific dislikes:

I dislike that it's only for ages 3-6. It should be for older children and younger too.
The color should be brighter, a little bit of music also.
I have a 4-year old with short attention span. It's hard to read them. The instructions aren't clear, you need something easier.
The bucket in the pulleys didn't work.
Not all of the room is being used. The lathe is broken and the turntable is being repaired.
The room is too small, some exhibits were not working.
The tire was hard to spin.
The walls should be brighter - purple is too dark.

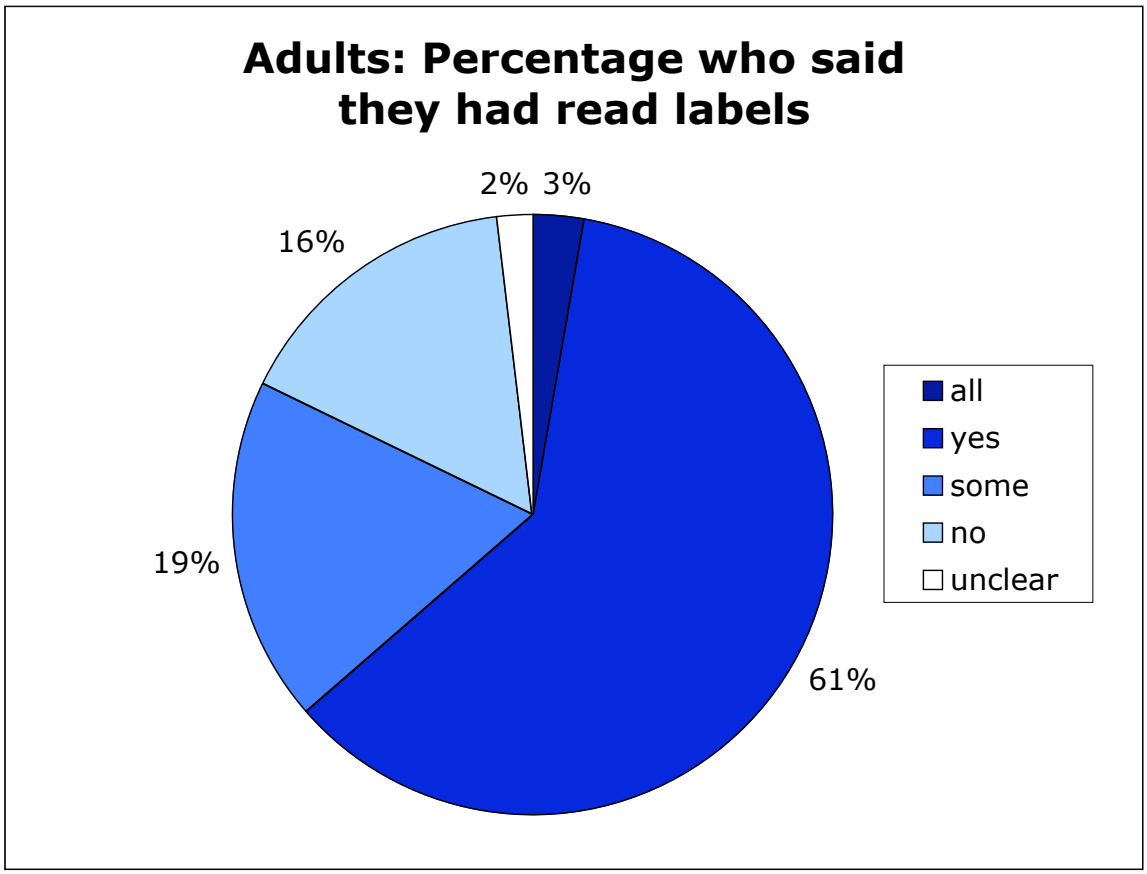
f) How did adults respond to the trilingual labels?

Visitors were asked a number of questions about their responses to the labels. Overall, 82% of adults said they had read at least some of the labels, 62% made a positive comment about them, and fully 86% said they would recommend that CDM have labels in other languages as well as English.

First, adult visitors were asked whether they had noticed that the labels in the exhibition were in different languages. Almost all visitors (94%) said they had noticed this. This number may be inflated due to the biased phrasing of the question (which was intended as a warm-up and setting of context); nevertheless it was a promising sign that almost all adults said they noticed the multilingualism of the labels.

After this, visitors were asked whether they had read or used the labels. The results are summarized in Figure 16: Overall, 82% of adult visitors said they had read or used at least some of the labels.

Figure 16: Percent of adult visitors who said they had read *Secrets of Circles* labels



The number of visitors who said they read at least some labels was independent of home language and gender, but did depend on whether visitors were repeat or first-time visitors to the exhibition. Specifically, 78% of first-time users of the exhibition said they had read at least some of the labels, but this number rose to 97% of repeat-visitors to the exhibition. (chisq(1)=5.45, p=0.02). One interpretation of this finding is that almost every adult who was returning to the exhibition felt that the labels had something enriching to offer. An alternative interpretation is that repeat visitors tend to be more frequent readers than first-time visitors. A third possibility is that visitors did not distinguish between this visit and previous visits, in which case the 97% reading rate may refer to the number of visitors who believed they had read something at some point in some visit. Whatever the reason, the data suggest that there is at least some label reading by visitors beyond their first visit.

Visitors were also asked for their overall response to the labels, and these are summarized in Figure 17. As mentioned previously, 6% of the respondents said they had not noticed them at all. A further 30% were neutral or mildly positive in their responses. For example:

> Fine.
> That's OK.
> I'm used to it.

I don't really care.
I mostly read the English ones.
I tried to figure out the third language.

Almost two thirds of adults (62%) noticed that the labels were multilingual and had a decidedly positive response. For example:

Good idea.
This is a diverse area, it just makes sense.
Helpful.
Thought it was great, I just wish I spoke other languages.
That's good, so different people can read them, you get a better explanation.
It's awesome.
It's good for everybody.
I liked it – my son is actively learning Spanish, so it was nice for him to read signs in Spanish.
It's good to have the signs in many languages; my kid's grandparents could read English.
It's good, all kinds of people come.
It's a good idea, we figured it out.
Good for people that can't speak English.
Excellent that it caters to different groups.

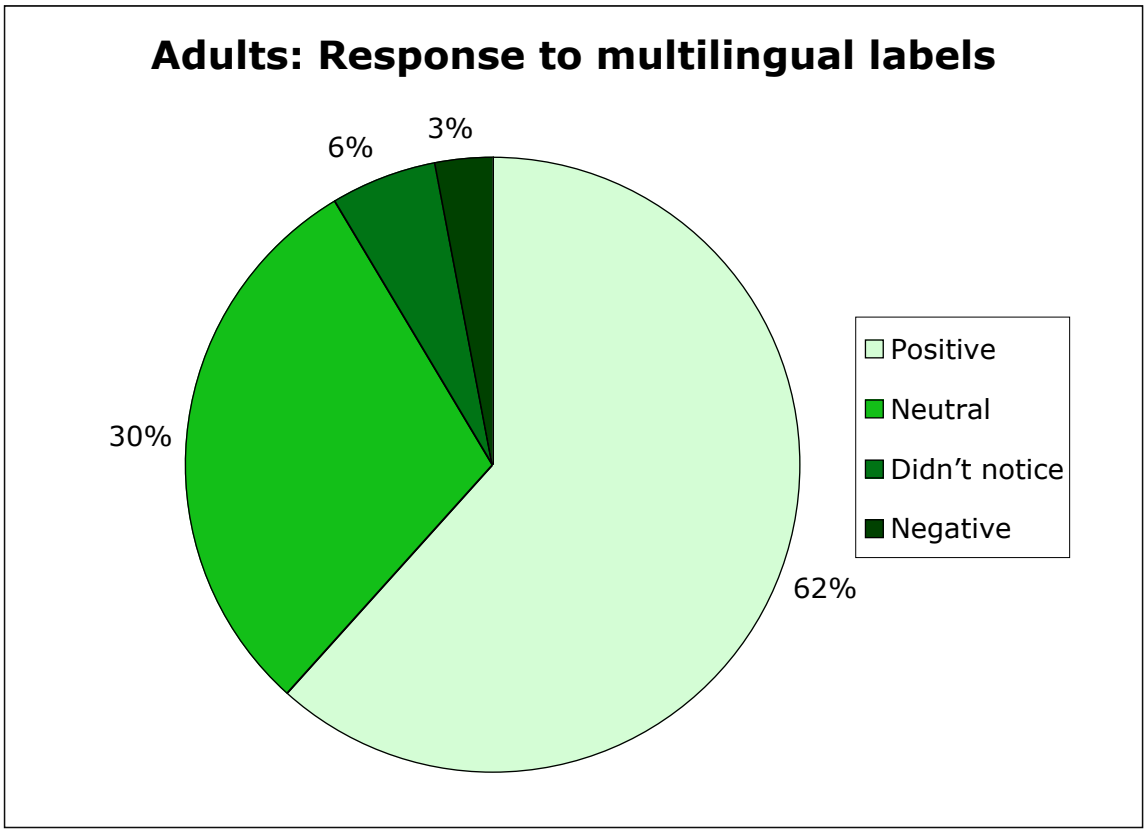
Included in this percentage are four responses that requested even more languages than the three presented in the labels:

It's good, maybe more languages.
Fine. I think they should add Chinese: there are a lot of Chinese people here, it's hard for me to understand.
There was no Cantonese, and no Japanese, and the signs were brief.
Good, hard to capture them all, just three isn't really fair.

Only 3% of the adults had something negative to say about the multilingual labels:

You need something easier to read.
It's like "oh OK, here go again." Aren't we supposed to be an English-speaking state?
I don't really know what they were – it makes me confused. I get distracted when I can't find English.

Figure 17: Overall response of adults to multilingual labels



In addition to these general responses, a few visitors spontaneously commented on the specific choice of languages: 7% said they understood and supported the inclusion of Spanish in the labels:

> I think English and Spanish is what most people would read.
> Definitely Spanish and English.
> Just English and Spanish.
> Yes, I am a bilingual teacher so it makes me happy to see English and Spanish.
> I think they should follow the languages of the city: If they have a lot of Spanish speakers, then they should do it. It's a great idea: it exposes kids to other languages.

Those visitors who spoke Spanish as their home language were especially supportive of the labels, with all 9 in the sample offering strongly positive comments.

In a similar way, 5% of adults said they understood why Vietnamese was included:

> I noticed they added Vietnamese – makes sense to me, because there are just as many Hispanic people as there are Vietnamese.

We have a huge Vietnamese community.
If it's Vietnamese-based, then duh, it should be in Vietnamese.

but 7% wondered why Vietnamese was included in particular.

I'm fine with it, but I'm curious: why Vietnamese?
I wasn't sure if [the Vietnamese language] was because of the exhibit and the Asian theme.
English and Spanish are completely understandable, but it's probably really hard to pick a third.
Are Vietnamese and Mexican the biggest communities in San Jose? If they are, the signs in those languages are understandable.

Some visitors also commented on aspects of the labels other than the fact that they included multiple languages. Most commonly, they talked about the usefulness and understandability of the labels as motivators to their reading:

It is useful to read what the circles are suppose to mean.
I read the labels, they helped me understand what was going on.
A little bit, they were more instructional.
I read all of them, they are very interesting…
Yes, because I had to try to see how it worked or functioned.
Yeah, to see what the exhibit was about.
I used them to understand what was the purpose behind each exhibit.
I did, they are easy to understand.
Reading them makes it easier to understand.
They really helped clarify because I didn't always know what to do [at each exhibit].

Only three visitors shared a (non-language related) criticism of the labels:

…[there was a] lack of instructions, more directions would be nice.
They were too small.
We just need a second card to explain why…

Finally, visitors were asked whether they would recommend that the museum create labels only in English or in other languages as well. Only 2% of the adult visitors said they would recommend only English in CDM's labels; 11% had no preference, and fully 86% said they would recommend that labels be English and other languages as well. It is worth mentioning that most of those who supported multilingual labels (54 out of 92) said that the language they mostly speak at home was English, so these were not just people who personally needed the multilingual labels. Responses to this question did not depend on whether the adult's home language was one of those represented in the exhibition (viz., English, Spanish, Vietnamese), or not.

Comments from the supporters of multilingual labels fell into three main categories: (i) such labels would help them personally to understand an exhibition; (ii) such labels would help others from different cultures and linguistic groups to understand the exhibition; or (iii) such labels would help people who were trying to learn a new language.

(i) 6% of all adults felt personally helped by the multiple languages on the label:

… I read the Spanish ones.
…the ones in English and Spanish I could understand.
… Sometimes I read the English and sometimes I read the Spanish.
… It's great – our family is bilingual.

(ii) 28% of all adults felt that multiple languages would help others, not necessarily themselves. For example:

It's great for people that visit from other areas; it's necessary.
People have to know, people don't just speak one language.
English and other languages, for everyone to enjoy, it doesn't bother me. A lot of people bring grandparents and family that don't speak English, so why segregate?
More languages would be good. I usually use English, but I like [the idea of] Spanish for people that don't read English.
A lot of different people come and it's good to attract different groups of people.
For people who are not fluent, it is good.
More languages for a diverse community.

(iii) 7% of all adults talked about the value of multilingual labels as tools for learning or being exposed to new languages. For example:

I am a bilingual teacher so it makes me happy to see English and Spanish.
It's good, it's a positive thing, it's good for kids to see the different languages.
We also were in the dragons exhibit, we were reading a scroll in Japanese and then the English word for it.
When I was in the other room, I brushed up on my Spanish, it was interesting to look at.
Helped me to learn Spanish.

g) Were any of these responses different for parents of different ages, language groups, or other demographic characteristics?

Findings related to demographic differences are reported in the relevant sections above.

—

Exit Interview Study with Children

Purpose

In addition to the adult interviews, an exit interview study was conducted with 89 children in the target range (3-10) from the regular weekend audience, to determine how they responded to the *Secrets of Circles* exhibition.

The main research questions for this study were:

a) *What kinds of responses did children from CDM's general family audience have to the exhibition?*
b) *Did children see any circles in the exhibition?*
c) *Did children make connections between the exhibition and their own lives?*
d) *Did children learn anything about circles in the exhibition?*
e) *Were any of these responses different children of different ages, genders, home language, or familiarity with the exhibition?*

Methods

A total of 89 children from multigenerational family groups were interviewed during four weekend days and one holiday between November 26 and December 26, 2006.

Families were recruited just prior to their exiting the gallery in which *Secrets of Circles* was located. For the purposes of the study, groups were considered as "families" and were eligible for recruitment if they were observed to include at least one member of the targeted audience (3-10 year olds), as well as at least one adult. In each case, the next eligible family to cross an imaginary line near the exhibition exit was approached. Adults were asked whether they would consent to their children being interviewed, and the children were then asked for their consent. If there was no child within the target age range after all, the family was given a gift, thanked, and left to continue with their visit.

The overall refusal rate for children's interviews was 29%. The two most common reasons for refusal (when given) were:

- Following the needs or wishes of the child(ren) in their group, including needs to eat, go to the bathroom, or pulling them in a different direction (36% of all refusals);
- Having too little time (17%).

Families who agreed to participate were invited to sit on a bench just outside the exhibition (where they could not see it).

All interviews were conducted by fully bilingual interviewers in Spanish or English, according to the preference of the interviewee. Spanish interviews were later translated by the interviewers into English, for further analysis.

Participating children were shown a sheet of color photographs of the individual exhibit elements to help them remember what they had used (see Appendix F). In families with several children, every child within the target age range was interviewed, but only one (the first one interviewed) was included in the analysis, so that the 89 children represent 89 different families. Children who were outside the target age range were given toys to occupy them, so that the family could remain together.

Children were asked the interview questions as much as possible, but some children (especially the younger ones) did not always understand what was being asked, and if a child was extremely shy or very energetic and unfocused, the interviewer did the best they could to get at the question with alternative phrasings, and then let the child go. For that reason, each question had its own response rate, and these were generally lower than the response rates for the adult interviews. For a complete list of children's interview questions, see Appendix E.

All children in the family were given small gifts at the end of the interview, to thank them for participating.

Exit Interview Participants

Table 10 presents some of the demographic and background information of the 89 children who participated in the interview.

Table 10: Children who participated in exit interviews

Demographic / background factor	Categories	(N=89)
Gender	Female	55%
	Male	45%
Age	3-5	48%
	6-10	52%
Region currently lived in	San Jose	21%
	Santa Clara County (excl. San Jose)	30%
	Santa Cruz County	2%
	San Benito / Monterey	2%
	North Bay	7%
	East Bay	19%
	Central California	2%
	Northern California	2%
	Southern California	1%
	Outside California	3%
	Unknown	9%

Demographic / background factor	Categories	(N=89)
Group size	2	22%
	3	22%
	4	27%
	5	7%
	6	4%
	7+	9%
	No response	8%
Language spoken at home*	Target languages:	
	English	71%
	English only	64%
	Spanish	3%
	Vietnamese	0%
	Chinese / Mandarin / Cantonese	6%
	Other Asian languages	8%
	All languages not listed above	11%
Ethnic origin / nationality (open-ended question, verbatim responses)*	White / Caucasian	28%
	(Specific Asian country excl. Vietnam)	16%
	American	9%
	Asian	12%
	European	2%
	(Specific non-Asian country)	15%
	Mexican	1%
	Vietnamese	0%
	Hispanic	6%
	Latino	1%
	(All other self-identifications)	<2% each
Visited museum before	Had visited before	61%
	First visit	30%
	No response	9%
Seen exhibition before	Had seen *Secrets of Circles* before	27%
	First time seeing *Secrets of Circles*	65%
	No response	8%
Member	Member	35%
	Non-member	57%
	No response	8%

- These numbers may add to more than 100% because of families who gave multiple answers.

Summary of Findings

Children particularly valued the number and variety of activities the exhibition offered, as well as the chance to explore and learn about circles and other shapes. About half of the children named mathematical or engineering properties (roundness, lack of corners, ability to spin or roll) as the best thing about a circle. With the help of a sheet of photographs, two-thirds of the children could identify a circle in their favorite exhibit. About a third of the children identified something from their own lives that they were reminded of while using their favorite exhibit.

Detailed Findings

a) What kinds of responses did children from CDM's general family audience[20] have to the exhibition?

To determine what aspects of the exhibition children particularly appreciated, they were asked to complete the sentence: "Being in the Circles room was fun because…" Their answers showed that they particularly enjoyed the variety of activities in the exhibition, the theme of circles and other shapes, some specific exhibits, and the opportunities to learn.

Very commonly (28%[21]), children talked about activities that had made their experience fun. For example:

> There was lots to do and all in circles.
> Playing.
> It had games and science, 'cause science is my favorite.
> I got to play with a lot of circle toys.
> 'Cause you got to create a lot of stuff.
> You could play, there's different shapes.
> You could do circle things with moving and carving.
> I learned how to carve circles.
> Because pressing the button to take the picture [was fun].
> The bridge was fun to walk over.
> I liked the tire because you could put your feet on the wall.
> It was very neat, I liked how you could spin.
> Sometimes you can hit them and make them fall off.

[20] By "general family audience" we mean the weekend and holiday audience of casual visitors, i.e., those who are not part of organized groups such as field trips or camps, nor did they come to the museum on a day with a culturally-specific special event.
[21] These aspects of children' were not mutually exclusive, so one response could fall into several categories.

Another common theme (18%) was the idea of circles and other shapes as a key aspect of children's enjoyment. For example:

> I got to learn a lot of things about circles.
> I got to play with a lot of circle toys.
> There was lots to do and all in circles.
> You get to learn how you can make new circles.
> It showed me how important circles are in my life.
> The circles could be in a cylinder, triangles, spheres.
> Because it makes shapes.
> There were a lot of circles.
> I like circles.
> I liked to see all the shapes.
> It had circles and wood that my uncle made ornaments with, that were in circles.
> It was fun to explore all the circles.

11% of the children mentioned specific exhibits within the exhibition as the reason it was fun:

> I learned how to carve circles.
> The bridge was fun to walk over.
> You can run in it. [Giant Tire].
> The ripples, it was cool.
> I was playing with [pointed to gears].
> I saw the drill.

8% of the children mentioned valued the variety of their experiences:

> You could play, there's different shapes.
> There was a lot of stuff to do.
> It was fun because I got to play and do different things.
> So wonderful because it was really beautiful and had all kinds of wonderful stuff, and my friends are here too.
> They have all different kinds of things.

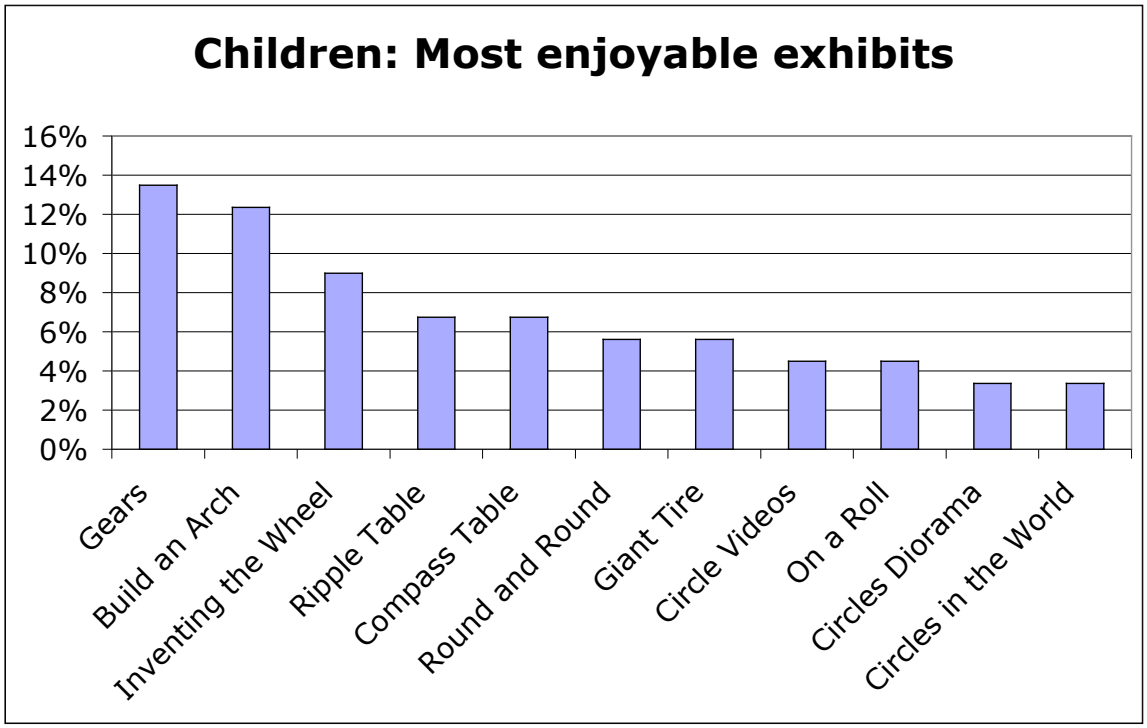
The last frequently mentioned reason that children found the exhibition fun was because they learned something (8%):

> I learned how to carve circles.
> You get to learn how you can make new circles.
> It showed me how important circles are in my life.
> I got to learn a lot of things about circles.
> It was great and I like learning about circles.

Children were also asked to identify their favorite exhibit from a sheet of photographs, and to talk about it in as much detail as they were willing to share.

Figure 18 lists all exhibits that were named as favorite by at least three children. This graph, like the one for adults, shows that there was quite a broad distribution of favorites across the exhibition, with at least half of the elements named as favorite by at least three people.

Figure 18: Exhibits that children reported as their favorite



Gears was very popular with both adults and children, while Spin Pictures was the overall favorite among adults but did not appear in the list of favorites of children. Given the children's focus on activities as sources of fun, perhaps Spin Pictures was less interesting to children because it required understanding the creation of a representation of motion, with much of the interaction time spent waiting and watching, rather than actively turning or moving something.

Table 11 gives the list of children's favorite exhibits, along with examples of some of their more detailed thinking about this exhibit. Specifically, the children were asked to talk about what made that exhibit their favorite, what they thought about while playing with it, and whether they thought there was a circle anywhere in the exhibit. These responses are analyzed more quantitatively in the next subsections, but examples are given here to show the variety of reasons for appeal, the opportunities for association, and the connection to the circles concept of the different exhibits.

Table 11: Selected examples of children's thinking about specific exhibits

Exhibit	Reason for being my favorite	Made me think about…	Where there's a circle in the exhibit
Gears	Because it moves, the motion. (m3) Because it was pretty cool. cool because you could put stuff together. (f6) I like lots of things that use gears. (m6)	…when you turn one gear, the other one turns too. (f6) …movement. (m6) …how I will improve my house or car or something that can work better because of circles. (m10) …a rainbow, the colors. (f4)	The gears are circles. (f6) [points to photo:] The centers of the gears. (m6) [points to music box dancer] The dress. (m8) A sign [points to exhibit label] (f4)
Build an Arch	I could climb over it with no hands. (f4) It was fun. I got to build it. (m7) Because you get to figure it out. And I walked over it, and it was still stable. (f9)	…going across a real bridge. (f7) It makes me think about India - the pictures on the wall are the same. (m7) I was thinking about how the center piece of the bridge could hold it all together. (f9)	Blocks. (m5) The handle [points to railing]. (f6) A half-circle [points to arch of bridge] (f9)
Inventing the Wheel	Because I just love it. (m3) It was very clear which one was easy or hard to pull. (f5) How things are heavier and softer, because one is light and one is heavy. (m6)	…my muscles. (m5) In Egypt they made the Jews pull hard on the wagons. (f5) …a boat and a car [where the one with wheels was the car, and the one without was the boat]. (m8)	Wheels. [pointed] (f4) The rope. (m5)

Exhibit	Reason for being my favorite	Made me think about…	Where there's a circle in the exhibit
Ripple Table	Because it has colors. (f5) Really cool, how it did those rings. (f8) When you touched the thing, flowers would sprout. (f9)	…bubbles hitting together. (m8) …water. You drop a rock and it makes circles, makes water vibrate. (f8) …fall. The flowers were growing, then they died like in winter, then they grow again. (f9)	When you touch the dots. (f7) When you put it down, [the wand] made the circles get bigger and bigger. (m8) When you touched the thing it vibrates out, makes circles. (f9)
Compass Table	I like to draw circles. (f6) Because it has a light. (f7) Because you don't have to touch it to make it turn. (m7)	…having fun. (f7) …circles. (m7) It made me curious. (f8)	Drawing [points to a circles sign on the photo of exhibit]. (f6) Everywhere. (m7) The table. (f8)
Round and Round	Because it's like a tornado shooting up. I tried to make it into a circle. (m5) It has blue. I turned it. (f4) The lines made a circle. (m6)	I was thinking about the pond and making circles in the water. (f4) …a big house being sucked up. (m5) …circles. (m6)	The lights. (m5) All around the blue part [points to the wood panel in photo] (m5)
Giant Tire	I liked when my mom turned the wheel – I turned upside down. (f5) I felt very cozy and it felt very relaxing. I	… a roller coaster. I like roller coasters. (f5) …big tires on big trucks. How it would be to live in one. (f7)	The tire. (f5) The wheel. (m8)

Exhibit	Reason for being my favorite	Made me think about…	Where there's a circle in the exhibit
	tried to see other people and how they feel, and they felt cool. (f7)	…one of those monster trucks because the wheels like them. (m8)	
	It's like a force. Like a pushing and pulling force. And you go backwards and forwards. (m8)		
Circle Videos	I do that at home. (f5)	…being hungry [video showed pizza]. (f5)	On the screen. (f5)
	There were circles in the pizza. (f5)	It reminded me of going downstairs and playing with water [photo shows bubbles on video] (f9)	A bunch of them. (f9)
	You can rewind it and fast-forward it. (f9)		The pottery and fireworks. (f10)
On a Roll	The toys in there. I threw the balls around. (f4)	…a tire, how it spins. (m7)	Tennis ball. (f4)
	I liked to spin them and make them fall off. (m8)		The metal thing [points to turntable]. (m8)
	I liked rolling tubes, spin them. (m7)		
Circles Diorama	I came to it every day. (m4)	…flowers in Romania. (f5)	
	Pink color. (f5)		
	Flowers. (f5)		
Circles in the World	Because you get to row and put stuff on. (f5)	…fishing. (f5)	The boat. (f5)
	It has paddles. (m5)	…paddling in a real boat. (f5)	
	There is food in it. (f5)		

b) Did children see any circles in the exhibition?

As already mentioned, children were asked to say whether they thought there were any circles in their favorite exhibit. Table 11 showed examples of the circles they identified in the most popular exhibits overall. **In total, 87% of the children said that there was a circle (or circles) in their chosen exhibit, and 64% could follow up by correctly identifying a specific circle in the exhibit.** The first number is probably high, in part, because of a pleasing and affirmation bias, so it is really the second finding that is more interesting. One reason the second number is so high may be that the children were looking at a sheet of photographs of all the exhibits, in order to help them remember which they had used; these doubtless served also as perceptual cues for locating circles, and many of the children did point to the photos when they identified a circle in their exhibit. Nevertheless, the children clearly knew what they were seeing when they identified the circles, and the children saw a variety of circles within most exhibits, as reflected in Table 11.

c) Did children make connections between the exhibition and their own lives?

As mentioned, the children were asked what they were thinking about when they used their favorite exhibit. **Over one third of them (36%) named objects or activities that were not directly present in the exhibit they were describing, thus making clear connections between the exhibits and their own lives.**

The following is the complete list of the responses of the 36% of children whose favorite exhibit got them thinking about something in their lives beyond that particular experience, which highlights the diversity of connections children made:

> Fishing.
> How I will improve my house or car or something that can work better because of circles.
> Basketball, b/c it builds your leg muscles, and you have to run in basketball, I like basketball.
> Bubbles hitting together.
> My muscles.
> It looked like a real bridge.
> A car - like the wheels.
> Fall. The flowers were growing, then they died like in winter, then they grow again.
> Being hungry. [video showed pizza]
> Paddling in a real boat.
> About when it's time to go to school.
> A computer game, there is a computer game I have that has gears.
> In Egypt they made Jews pull hard on the wagons.
> Hockey [magnetic pucks].
> A boat and a car [where the one with the wheels was the car and the one with out was the boat].
> It makes me think about India - the pictures on the wall are the same.

Going across a real bridge.
Sewing.
Flowers in Romania.
It reminded me of going downstairs and playing with water. [photo shows bubbles on video]
A rainbow, the colors.
When they showed it on the screen it didn't make me think of anything but when you actually saw it happening it reminded me of earth and sun spinning.
Me drawing, figuring out what I should draw, next time I draw.
I was thinking about playing with other games.
Where I used to live because I used to draw there.
One of those monster trucks because the wheels look like them.
Pirates.
A big house being sucked up.
I felt like I was in a car.
A roller coaster. I like roller coasters.
Big tires on big trucks. how it would be to live in one.
My ball I have at home. It makes me happy when I learn new things.

d) Did children learn anything about circles in the exhibition?

The children who experienced the exhibition were not pre-post tested for changes in their knowledge of circles, because this was felt to be too challenging a format for such young museum visitors. However, the interviews did provide some indicators that the exhibition may have contributed to children's understanding of circles.

Some evidence came from the children's completion of the sentence: "The best thing about a circle is…" **In finishing this sentence, 26% of children talked about the physical and engineering properties of objects that had a circular shape, which was one of the key underlying themes of the exhibition.** This represents the beginnings of a foundational connection between the physical and mathematical worlds that underlie much of scientific thinking:

Specifically, 13% said that the best thing about a circle was that it can roll. For example:

… that they roll.
… that you can roll it.
… things could roll.
… that it's easier to roll than a square.

As a variation, a further 6% of children said that the best thing about a circle was that it could turn or spin:

… sometimes you get to spin it.
… when they turn.

… going around.
… it can turn, and turns smoothly.

A small number, 3%, recognized that circles can help other things move:

… that a circle can make cars move.
… if it's a wheel on a vehicle, it gives it a smoother ride.
… it can help move cars; it makes them faster and smoother.

Lastly, 3% appreciated that circles can be used as building components for other things:

… it's a ball.
… it can make different shapes like triangles and cheese pieces.
… it could be used in lots of different ways to make … other stuff like gears and wheels.

While there is no unambiguous evidence from pre-tests, these children seem to have been influenced by the exhibition in their thinking about circles as functional objects with useful physical properties.

A further 26% of children said that the best thing about a circle was that it was round, or had no corners / edges / sides:

… it's round.
… it has no sides or corners.
… it's smooth.
… no squiggles, no points, or edges around it.
… no points, 'cos not all shapes have them.
… it doesn't have any sides or spikes.

While this is somewhat weaker evidence of learning, the phrasing the children use seems to suggest that they have a visceral or physical feel for the shape of circles, again something that was emphasized in the *Secrets of Circles* exhibition.

There is also evidence of learning as perceived by the adults in the family groups. Late in the set of interviews of both parents and children, a new question was added that asked the adult to reflect on whether the child with them had learned anything about circles while using the *Secrets of Circles* exhibition. Because this question was added late in the process, the sample size of adults is small, N=29 from the adult interviews, and N=20 from the children's interviews. By pooling the responses, we can see some patterns from the N=49 distinct family groups:

Of this group of adults, 12% felt that it was unlikely their children had learned anything about circles. A further 16% said they didn't know or could not be certain. 14% thought their children had been too young to learn about circles from the exhibition. 18% said that they

were concerned that their children were too young to learn about circles from the exhibition. But most of the adults thought their children did learn about circles: 24% believed the children had learned something, but didn't name anything specific, and well over a third (39%) did name something specific they thought the children had learned. These responses were:

> Yes, because he noticed how the round circle wheel made it not be bumpy.
> She learned any element can become a circle visually when turned. [referring to Spin Pictures, which was the child's favorite].
> …she learned with the compass, that you can make circles with it.
> Yes, how to make circles with compasses.
> Learned about the movement of wheels.
> Yes, he likes how one thing moves the other.
> Yes, we can have teeth on a circle and that helps it move.
> She said the gears really does work, she kept doing it over.
> Yes, the gears, inside it, how they worked.
> Figured out how wheels interconnect and turn [with gears].
> Yes, there's different size circles, and in lights.
> We were talking about how the center didn't spin as fast as the outside of the circle.
> Learned stuff about building and were amazed it was so stable.
> Some of their practical uses.
> Yes, finally figured out cement block had wheels and other didn't, and the one that did was easier.

e) Were any of these responses different for children of different ages, genders, home language, or familiarity with the exhibition?

Children's responses were surveyed for significant differences based on their age, gender, home language, and whether this was their first time using the exhibition. Most of these variables did not significantly affect children's responses to the exhibition.

The only variable that showed a pattern of differences was age:

- When completing the sentence: "Being in the Circles room was fun because…,"older children were more likely to give a reason that had to do with the specific features of the exhibition. (61% versus 40% of responses, chisq(1)=4.05, p=0.0443). For example, younger children tended to say that being in the room had been fun because they had liked the room, or been with their family, whereas older children were more likely to say that they had enjoyed the large range of activities, the chance to explore circles, or the fact that they had learned something. This is unsurprising, given that older children are more likely to be able to reflect on their own experience and the factors contributing to it than younger children. On the other hand, it suggests that older children were particularly engaged by features of the exhibition rather than simply the chance to be out with their families.
- When asked to finish the sentence: "The best thing about a circle is…," older children were more likely than younger children to be able to name an appropriate property of a circle. (78% versus 37%, chisq(1)=15.4, p<0.001). While this may be due to influences beyond the

exhibition, such as schooling, it is interesting that older children named more geometrical properties of circles (such as roundness, or lack of corners) as well as physical properties of circular objects (such as ability to spin, roll, or help other things move), which were a particular focus of the exhibition.

—

The Exhibition's Impact on Vietnamese-Descent Families (at Children's Discovery Museum of San Jose)

Background

The Secrets of Circles exhibition was designed not only to help children learn about circles, but to reach out to two particular audiences: Latino and Vietnamese. Evaluation studies with the general audience showed that very few Vietnamese families were visiting: only 4 out of 107 adults interviewed said they spoke Vietnamese at home. It was therefore decided to invite a small number of Vietnamese families and a Vietnamese community leader to view the exhibition and give their in-depth feedback.

Purpose

The in-depth interviews addressed the following questions:

a) *What kinds of responses did Vietnamese families have to the exhibition?*
b) *Did adults believe their children were learning anything in the exhibition?*
c) *Did adults see any gender differences in their children's behavior in the exhibition?*
d) *Did the families notice any Vietnamese aspects of the exhibition and make connections to their own lives?*
e) *How did the families use the trilingual labels?*
f) *Did the Vietnamese families appreciate this exhibition as an act of invitation by CDM?*
g) *What kinds of obstacles did the families see to greater museum visitation by the Vietnamese community in San Jose?*

Participants

Vietnamese families:
For this study, 8 Vietnamese families were recruited through CDM's existing relationships with various local community organizations, including Girl Scouts and the International Children Assistance Network (ICAN). The call for participants emphasized multigenerational families and families where the adults speak primarily Vietnamese. Participating families spent approximately an hour with the researchers, and were paid an honorarium for their time as well as receiving complementary admission to the museum. All interviews took place during the weekend of August 4 and 5, 2007. Table 12 lists some of the demographic characteristics of the participating families.

Table 12: Vietnamese families who participated in in-depth interviews

Family	Genders, ages of children	Genders, estimated ages of adults	Visited CDM before?	Seen *Secrets of Circles* before?	Language(s) spoken at home
A	F4	F30, F>60	No	No	Vietnamese
B	M2, F7, F8, M10	F30, M30	Children and father only	No	Vietnamese
C	M4, M9	F30	No	No	Vietnamese
D	M7	F40, F18, M22	No	No	Vietnamese (except brother M22: Vietnamese and English)
E	M3, M7	F30, M30	No	No	Vietnamese, Chinese (father born in China)
F	M4	F30, M30	No	No	Vietnamese
G	M3, M10	F30, M30	No	No	Vietnamese
H	M7, M8	F30, F>60	Children only	No	Vietnamese

Community leader:
Also based on existing relationships, CDM invited community leader Quyen Dinh to participate in an in-depth interview. Ms Dinh is the Coordinator of the Parent Workshops of ICAN, the International Children Assistance Network. ICAN is a non-profit organization whose mission is "to help children realize their potential and become the quintessential member of their family and their community." ICAN offers free workshops on child development for parents, grandparents, and care providers with children aged 0 – 5. These workshops take place over 6 weekends, and include a field trip to CDM so that parents can watch their children learn in an informal environment, and can discuss and participate in their learning. Ms Dinh knew about the *Secrets of Circles* exhibition but had not yet seen it. She visited the exhibition along with her workshop group on August 12, 2007, and participated in a 2-hour interview beforehand. Members of the workshop group also offered occasional comments on the exhibition, which have been included in the findings below. However, most of their visit was spent in other parts of the museum.

Methods:

All family interviews were conducted in Vietnamese by Le Vu, a bilingual native of Vietnam. She later summarized, translated, and documented the interviews, focusing on the families' responses to the main research questions and adding quotes where possible. The community leader, who was fluent in both Vietnamese and English, was interviewed by the lead evaluator in English.

The interviews were an attempt to understand the Vietnamese families' experience in some depth, focusing in particular on their response to the Vietnamese components that had been included (trilingual labels, round boat, and bamboo building material). Appendix J provides the interview outline that served as a guide; however, the interviewer was encouraged to take a conversational approach with families throughout their experience, making their comfort a top priority.

Families spent approximately an hour with the interviewer in the exhibition. The first half of this time was spent using the exhibition spontaneously, while the interviewer joined the group as a participant observer: watching what they did and asking questions to try to understand their behaviors and underlying motivations. The second half of the time was spent in a semi-structured interview which had themes but no rigid questions. The focus was on the adults in the group, mostly one at a time but occasionally as a group. Once again, the interviewer attempted to make the discussion feel more like a conversation than a formal interview and encouraged the families to be very honest in their feedback.

The community leader participated in a similar way, but with a longer interview period. This allowed her to share her personal responses, to comment on the significance of the exhibition to the local Vietnamese community, and to offer her interpretation of some of the intriguing findings from the family interviews.

Interviews were analyzed qualitatively, using the research questions listed above as an organizing framework. The findings are reported primarily using quotations rather than numerical frequencies, to reflect the emphasis on in-depth understanding of a small group of families, and results may not be typical of the larger Vietnamese community.

All findings reported below were reviewed and approved by both the Vietnamese interviewer and the community leader.

Summary of Findings

Most of the small group of adults who were interviewed in depth responded very positively to the exhibition, seeing it as helping their children learn as well as have fun. One parent was concerned that the exhibits were not educational enough for his 10-year old son. The community leader considered the exhibition deeply valuable, with its technological emphasis, connections to daily life, opportunities for children to engage in motor skills, build

confidence, develop language skills, and the chance for parents to broaden their definitions of learning.

Families varied widely in terms of how much they saw Vietnamese culture represented in the exhibition, with the Round Boat being the most widely recognized Vietnamese element. Several first-generation parents were concerned that the inclusion of elements from other Asian cultures would mislead the public about what constituted Vietnamese culture. By contrast, the community leader, who was second-generation Vietnamese, saw herself substantially reflected in the overall Asian theme of the exhibition.

Families used the multilingual labels in a variety of ways, and most were supportive of the labels and/or appreciative of the museum's attempts to include their community.

Detailed Findings

a) What kinds of responses did the Vietnamese families have to the exhibition?

Almost all of the adults in the Vietnamese families responded very positively to the museum overall, and to the *Secrets of Circles* exhibition in particular. For example:

> The exhibits are very good for kids to develop their interest in science and math. Many of these things they can't find anywhere else, like the round boat, or the lathe. And there's no other way to touch or get experience with things like the cars with different wheel shapes, or pulling blocks with wheels and no wheels, or getting inside a big tire.
>
> The exhibits are really good. This is the only place where our kids can see things like the big tire, the round boat, and the lathe, and they can play, and learn how to draw circles, how to build an arch, use pulley system, the lathe, taking picture of moving objects.

b) Did adults believe their children were learning anything in the exhibition?

Almost everyone interviewed described the exhibition as offering their children opportunities for learning as well as fun. In this respect, they seemed no different from the general visiting audience:

> The exhibits are good for kids. They open the door for knowledge about circles, science and math, and kids have a lot of fun at the museum.
>
> The exhibits are very useful for kids. We've driven by the museum many times, but had no idea about what it was or what was happening inside. Our family went to Disneyland last week, but our son didn't have as much fun as when he's at the museum. All the exhibits in the museum are reachable, touchable. They're all fun and

> have educational goals, that encourage kids to learn or have more interest in science and math, especially the circle exhibits.

One parent felt that even she and her very young children could learn something:

> All the exhibits are good for my children, but they are too small to learn, so maybe they're just getting some ideas about circles, and how things work. For me, this is the first time I've realized how important circles are to human scientific inventions. Everything here has some educational goals to give kids while they play at the museum.

By contrast, one parent expressed some skepticism about what was being learned:

> The exhibits are good for kids under 6 years old, because in that range they can play and see circles in the exhibits. But my eldest son is 10, so he doesn't learn anything from the exhibits – they're not educational, they're just for fun … The design of the exhibits isn't clear. It's as if they're half learning, half playing, so they don't have a full effect.

Community leader Quyen Dinh, who runs workshops that teach Vietnamese families about child development, thought that there were many ways in which children were learning in *Secrets of Circles:*

> There's a strong theme of technology, from wheels to bridges, to the film, and how circles impact all of your life, that's really interesting. And those aspects of technology are things we take for granted: we drive a car or ride a bike and don't think about the different motions that are put together.
>
> Also the motor skills, seeing kids moving things, and for them to see their own ability to make change happen. Realizing "Oh I can make this block move," helps them build self-esteem and confidence. It also helps them build creativity and problem-solving: "how do I get this wheel to turn?" And it's a great way to develop their relationship to other family members, and older adults, because this is a communal space where you have to learn to interact with others, so besides the idea of "kindergarten readiness, "it's just good to be in a communal space like this.
>
> The language development aspect is great too – families in here communicating in English and Vietnamese, you see it everywhere, it says it's OK to speak Vietnamese, and you should, if you want to.

She also commented that the skeptical parent might not be so unusual:

> …I think in general, in Vietnamese culture it's more accepted to sit back and watch the kids play. Parents in our workshops will say they never realized that play is a way to learn. After the 6-week workshops they'll bring their kids back to the museum, or they'll start taking 15 minutes at the end of their day to play with their kids.

c) Did adults see any gender differences in their children's behavior in the exhibition?

Two parents thought there might be gender differences in the learning happening at the exhibition. One felt that the exhibition catered to boys more than girls:

> The activities are for boys more than girls. [Interviewer: What makes them like that?] They're more physical: the big tire, the lathe, pulling the bricks, the turntable.

The other felt that there were things for both genders, and that cross-over was possible too:

> Boys like the physical activities, girls like the boat or ripple tank with dragonflies, but sometimes the girls follow their brother to play with them.

Community leader Ms Dinh commented on gender, based on her experience of watching the Vietnamese families in her workshops:

> The parents don't realize these aren't gender specific, and they can let the kids go free... They tend to push girls to go to certain exhibits, and boys to other exhibits. They'll push the girls towards those ones with the clothes, and boys will be pushed toward things that involve physical things like pulling. There's a parental aspect to that, the parents try to create an identity for them, girl or boy. But if you take the parents out of the picture, I'd be interested to see which ones the boys and girls are attracted to. I bet the boys would like to use a lot more of their strength, and girls not so much. So I think it's intrinsic, as well as coming from the parents.

d) Did the families notice that Vietnamese aspects of the exhibitions and make connections to their own lives?

Overall, the in-depth interviews showed a broad range of responses from different families. Some said they saw nothing Vietnamese in the exhibition at all; others recognized several elements (particularly the round boat); and others identified as Vietnamese things that were not intended to be Vietnamese (such as the pulley, lathe, dragonflies, and compasses). There was also a strong theme of concern over mixing of cultural referents: Many of the families noticed that some elements were not Vietnamese, and several were concerned that these could misrepresent the Vietnamese culture. Many also requested more culturally specific elements, such as maps and music, as ways to help the museum's audience to learn more about Vietnam.

By way of background, the *Secrets of Circles* team had designed the exhibition to include a number of Vietnamese elements. They expected that the most salient of these would be the Vietnamese round boat, the ubiquitous use of bamboo as a building material, and the Vietnamese text in the trilingual labels. Other references included the rice sieve hanging on one wall, the photograph of a cyclo (a transportation device similar to a rickshaw), and the displayed children's book "Round is a Mooncake," which highlights a Vietnamese food.

Most families talked about having noticed the round boat, and some adults used it as an opportunity to share personal stories about their lives in Vietnam:

> The round boat reminds me of the area where I used to live in Vietnam. This kind of boat is popular in the middle of the country. In the mornings, I used to walk to the beach to see fish, shrimps or crabs unloaded from these boats. The bamboo, the pulley, and the rice sieve on the wall all remind me of the good times in Vietnam.
>
> My daughter, who is 10 years old, recognized the round boat and the well. She said she missed her grandma [who presumably still lives in Vietnam]. This is the first time I'm visiting this museum, but for my daughters, it's their second time. They've spent lots of time playing with the round boat.
>
> [Observation:] When she saw the round boat, the mother talked about where it's used in Vietnam, and showed her daughter how to use the oar.
>
> The round boats are used for fishing close to the shore or transporting fish from bigger boats to the shore. Look at these dragonflies, they remind me of my childhood: I used to chase them on the rice field with my friends. The dragonflies were very beautiful.

Some families recognized things that were not specifically intended to be Vietnamese, incorporating them into their personal histories:

> … the boat is about Vietnamese culture, and the small pulley system next to the round boat reminds me of the wells in Vietnam.
>
> The round boat and the lathe are Vietnamese.
>
> … the round boat and the pulley with the bucket reminded me of Vietnamese culture. I used to live in the country, where people used wells a lot.
>
> The compasses reminds me of the years in high school [in Vietnam].
>
> This [touching the rope and the bucket] reminds me the wells in Vietnam, wells were everywhere in the country where I lived. Water for daily use was taken from the wells like this, or from the rivers.

Two families did not recognize anything at all as Vietnamese:

> We didn't recognize anything having Vietnamese culture.
>
> The exhibits offer knowledge about math and science, especially the big tire, brick blocks, compass table, the gears, the pendulum…, but nothing about Vietnamese culture.

It seemed surprising to the interviewer that these two families could use the exhibit for half an hour without noticing any Vietnamese referents. One possible explanation came from a parent who said:

> The round boats aren't everywhere in Vietnam. I grew up in a part of the country where I never even saw one.

Another explanation is that some of the families thought the elements were not authentic enough to quality as Vietnamese:

> The exhibits helps kids to develop ideas about science, and the invention of new things, but it's more about math and science than culture and emotional relationships. It's been Americanized. [Interviewer: What do you mean by "Americanized?"] There's bamboo furniture, but it looks very neat and clean cut. Plus modern technology has been used to build the exhibits, and many of them use electricity.

> You said that they spent a lot of money on the bamboo furniture, but we don't use bamboo to make those kinds of things [referring to benches and exhibit frames].

Support for this explanation comes from another widespread finding within this group: Many of the families pointed out the non-Vietnamese elements of the exhibition. In particular, the hats and umbrellas were identified by several families as Chinese:

> The furniture is good, but the design of the exhibits and colors don't represent the Vietnamese culture. The hats with Chinese characters, combined with the umbrellas and pieces of fabric [next to the round boat] represent Chinese culture.

> The hats, the lantern, and the umbrellas all represent Chinese culture. Only the round boat and the rice sieve represent Vietnamese culture.

> The design and colors look more Japanese or Korean than Vietnamese. The umbrellas and hats are Chinese, and the bamboo poles [are made into] signs that look Japanese.

Many families were uncomfortable about the presence of the non-Vietnamese items, and proposed examples of stronger representations of Vietnamese culture as such. For example:

> Clearly, the umbrellas and the hats are not Vietnamese. If the museum can't find the Vietnamese hats, we'd rather have no hats at all! This exhibit doesn't really represent the Vietnamese culture. Why don't they put some pictures of rivers, famous pagodas, a map or a Vietnamese hat on the wall? Those would be things that would help people from other countries understand more about our culture.

> I recognized the round boat and the well, but the bucket should not be used to pull the fruits! It should be changed. Plus I'd like to see the yoke, or at least a picture of it, or a bamboo bridge – just a small and simple bridge that kids could walk on but it still makes any Vietnamese who come here recognize something very Vietnamese.

> It'd be nice if the museum could add more pictures to represent the Vietnamese culture, like the Dong Son drum, the One Pillar Pagoda, leaf hats, or bamboo baskets. Those red hats with Chinese characters on them would send a wrong message about the Vietnamese culture: people would think we use Chinese characters.
>
> This exhibit is about circles, so it has nothing to do with the Vietnamese culture. It lacks pictures to explain more about the exhibits. I bet many people don't know that the round boat is actually a boat that can float on the ocean surface; they might not know what it is, if there is not a picture of people fishing on that boat. It has to be something clearly Vietnamese, and those are Chinese umbrellas. About the colors, I think this exhibit should have the color of rice fields, banana trees and ocean, since our country has more than 200 miles of coastline.
>
> The *Circles* exhibits should make it clear whether the theme is countries in Asia, like China, India, Laos, Thailand, Cambodia, or just the Vietnamese culture. Otherwise it'll make people from other countries confused about the Vietnamese culture, when you have Chinese characters on the hats, and Chinese lantern and umbrellas.

While some of these responses are quite critical, is worth remembering that these families had been invited to the museum specifically because of their Vietnamese heritage, and that they were being asked to respond to the exhibition from that perspective. It is possible that these same families might be less critical of the exhibition if they had come across it without expectations of seeing their country represented.

By contrast with these families, community leader Quyen Dinh felt strong personal resonance with the exhibition, and was more inclusive in her interpretation of what counted as Vietnamese:

> I love the look of it, coming in to the bamboo makes it really comfortable. Because sometimes science exhibits are more professional or academic, and less inviting. But this one with the umbrellas, it's a really fun place to be in. And it reminds me of Vietnam, just the different bamboo that I've seen in my life, it makes me really comfortable. And the fabrics and colors feel very rich. …I love this round boat. When we were in Vietnam, my coworker actually sat in a boat and paddled around. It's awesome. The bamboo is really beautiful. It reminds me of the beachfronts in Vietnam, with the umbrellas, it's similar.

When she was told that many of the families had taken issue with the Chinese and other cultural elements, she proposed the following explanation:

> I'm second-generation Vietnamese. I was born here, but I've been to Vietnam as an adult. My identity is more general: not just Vietnamese but Asian, so I can identify with these different motifs. But for these guys, that's Chinese, and Vietnamese is quite different. And there's a pressure to be authentic. If it doesn't feel authentic to them, they won't embrace it. Because they're so strongly rooted in their Vietnamese identity,

> it has to be recognizable as authentic. They've grown up with these things, they used these objects.

Indeed, all the parents and grandparents who participated in the in-depth interviews, as well as all the adults on the workshop visit, were first-generation Vietnamese, so Ms Dinh was the only second-generation adult interviewed. While there were too few Vietnamese families interviewed in the regular audience to look for numerical trends, it is perhaps worth quoting one mother, who identified as ethnically Vietnamese but said English was the language her family mostly spoke at home:

> [Interviewer: Did you see anything that reminded you of Vietnamese culture or your own family history?] Yes, the hats at the round boat exhibit, those look very cute on my kids!

While only one person, she was probably second-generation Vietnamese, and she embraced the hats as part of her own culture.

This raises the question of whether a larger research study might reveal significant differences between the degree to which first- and second-generation Vietnamese families identify the cultural elements in the exhibition. Other evaluators (e.g., Garibay[22]) have reported differences between the responses of first- and second-generation immigrants to museums, though much more research could usefully be done in this area. It is interesting that the Vietnamese families were so supportive of the multilingual labels, yet so divided on the issue of objects in the exhibition as cultural referents. Perhaps language is a relatively clear, stable, cultural identifier while objects are messier and less universal. Or perhaps it was the mixing of cultural referents within one exhibit (the Chinese hats with the Vietnamese round boat, for instance), that was offensive to first-generation Vietnamese visitors.

e) How did the families use the trilingual labels?

From watching and talking with the families, it was found that they were using the Vietnamese parts of the labels in various ways for various purposes, including the following:

- An adult reading the Vietnamese label to understand the exhibit for herself / himself.
- An adult reading the Vietnamese label out loud to help a child.
- A young adult reading both the English and Vietnamese versions to understand the exhibit fully.
- A school-aged son reading both the English and Vietnamese versions as a way to help him learn both languages.

[22] Garibay, C. (2006). Washington Metropolitan Area Latino research study for the Program in Latino History and Culture, National Museum of American History, Smithsonian Institution. Available online at: http://americanhistory.si.edu/events/program-resource-files/PLHCResearchStudyReport.pdf

- A school-aged child encouraging a younger sibling to read the Vietnamese in order to practice his language skills.
- An adult checking the correctness of the translation from English to Vietnamese.

- In one case, a father stood back and did not read the labels at all. He was the father who was skeptical about his son's learning.

One behavior that was not observed was using the labels to explicitly discuss vocabulary, in spite of the fact that many of the children were learning both Vietnamese and English in their home or school lives. Ms Dinh commented:

> Many parents see it as interacting and playing, rather than using it as an opportunity to teach language. We teach that in our workshops too.

Another behavior that was not seen was parents or grandparents talking to the children in their group about their pride in their Vietnamese language and culture. Ms Dinh offered this explanation:

> Pride in the culture is not that explicit. You can see it in the parents as well. Passing on your culture or heritage isn't something you say but it's how you act, the values you instill. So parents might not share their stories. Also, they still have a painful history of leaving Vietnam as refugees. My parents didn't talk to me about their childhoods. The majority of the Vietnamese community is refugees.

Of course, it is important to remember that the sample of families was small and not representative of the larger Vietnamese community, so it may be that other families would have used the exhibit labels in other ways.

The Vietnamese interviewer believed that some of the workshop families she had informally watched had not read the labels because, feeling unconfident with English, they had not even approached them, and therefore did not see the Vietnamese part of them.

Ms Dinh thought the multi-lingual labels were very valuable to the community:

> With some newly arrived immigrants, they push their kids to only speak English, and they want materials only in English. But the majority of the community has a greater acceptance of really teaching Vietnamese to their children, and having their kids understand both. For newer immigrants, their priority is survival – learning the language. But for those starting families later, they recognize the significance of having their kids learn Vietnamese, because it's being lost so quickly: they see that happening with their cousins and with their friends.

f) Did the Vietnamese families appreciate this exhibition as an act of invitation by CDM?

Interestingly, none of the families mentioned the trilingual labels when asked if they had noticed any Vietnamese elements in the exhibition. Perhaps they thought the focus of such a question was the physical exhibits rather than the surrounding interpretation. Nevertheless, **once asked, almost all families were very positive about the trilingual labels. They saw them as providing access to the exhibits for Vietnamese speakers, a way for English-speaking children to further their Vietnamese language skills, and a form of outreach to the Vietnamese community.** For example:

> We are a big minority group in San Jose, so it's nice of the museum to help us to have our voice, our language, next to other communities.
>
> The labels in three languages are good for the Vietnamese and Mexicans who do not know English, also good for Vietnamese kids to learn new vocabularies.
>
> Our family has been in the U.S. for more than 20 yrs, and the kids go to Buddha temples to learn Vietnamese during the weekends. … I tried to teach him more about our culture, but he would not want to listen and he ran away, and now he knows how important this knowledge can be.
>
> The labels in many languages are good and necessary. Next time, we'll bring the children's grandparents to the museum – they would be thrilled if they could read Vietnamese labels and explain how things work to their grandchildren.
>
> The museum has tried a lot to reach out to the Vietnamese community through these exhibits, with the bamboo furniture and a huge round boat from Vietnam. It also shows in the Vietnamese labels. I'm glad I could read these labels and explain them to my grandchildren.
>
> It's very nice of the museum to make the effort to reach out to the Vietnamese community in San José. These labels show that the museum takes the diversity in San Jose's multiple cultures seriously. This makes me proud of our community.

Only one father was unimpressed, explaining that he assumed the labels were compulsory and therefore not indicative of an inviting attitude by the museum:

> I have no opinion about the labels – I didn't really look at them. I can see these kind of labels (in three languages) everywhere in public places. [Interviewer: What did you think of the translation?] It's OK. [Interviewer: How would it be different if the labels were only in English?] The museum has to have them in many languages.

Ms Dinh reflected on this father's response:

> Maybe they're affected by being a focus group: if they know you're trying to reach out to them, then of course you'll have these signs up. That's the minimum they'd expect.

> But also, you can live your life with Vietnamese literature – there's a lot available now… These folks probably access literature entirely in Vietnamese, and their whole lives are assuming you should have Vietnamese on forms, etc,. but for me it was never assumed. For me, it was an important symbol that this museum really encourages the Vietnamese community and recognizes them as an important community that deserves a space here. With my second-generation identity, I see these words as a symbol of what the Vietnamese community means to CDM. That may be different from the parents who come.

She herself was extremely appreciative of CDM's attempts to reach out to the Vietnamese community:

> What an amazing investment CDM is making to the community Maybe it's just me being 2nd generation, but these motifs really mean a lot to me. Without the bamboo and umbrellas, I would have had a very different experience, and I would have said this is not inviting the Vietnamese community to the museum, because there's nothing to remind them of their own culture. So symbolically it means a lot to me - it's clearly a lot of work - that our community means this much. If you had interviewed 2nd generation parents instead of 1st, you might have gotten quite different results. I'm so appreciative of it. I don't know of museums where things even look Asian!

g) <u>What kinds of obstacles did the families see to greater museum visitation by the Vietnamese community in San Jose?</u>

The families were quite forthright in stating things they thought were obstacles to museum visitation by the larger Vietnamese community. They cited factors such as: high admission fees, parking fees, distant location, poor physical visibility, and insufficient community awareness of the museum's existence due to a lack of advertising in Vietnamese media or connections with community-based institutions. They encouraged the museum to generate more public offerings that reflected Vietnamese traditions and culture. For example:

> Location and transportation – the museum is far from the center of the Vietnamese community. And the admission fee is high – there's an average of 4 people in a typical Vietnamese family, plus you still have to pay a parking fee. Advertisements need to be distributed through groups of organizations, religions, media like radio, TV, the county fair, that represent the Vietnamese community. Visiting the museum is a luxury, just for families with high income, and in those families both parents have to work during weekdays, sometimes even weekends. They have no time to take the children to the museum , or at least, not often. The museum should offer free admission to the low-income families through schools, maybe through Head Start. And the Vietnamese organizations should organize the trip with their own guides, and provide feedback to the museum….a while ago, I received a flyer, which wasn't clear: turned out that it offered free admission for children only.

I did not want to go to visit the museum, because my kids already visited the museum (school field trip). Besides, the admission fee is too high for our family.

It would be nice if there was a discount program for low-income families or families with many children, so the benefits of learning in a children museum could reach to families that can't afford it. The percentage of these families is high in the Vietnamese community. Also, some items such as a Vietnamese map, dress, hats, pictures of cities, festivals, markets on the walls would make the exhibits look more Vietnamese; right now it looks more Asian. The museum has not done well in advertising its activities to the Vietnamese community; they don't know about it, and never heard about it in the past.

Maybe there could be free admission for kids, given that it's a children's museum. Also more parking space, more advertisements through TV, newspaper, and radio to get to the Vietnamese community. There could be more items from Vietnam, and information about Vietnamese geography, like a map, or pictures of mountains and rivers. Also the culture: stories, legends, history and updates with incoming events, like the mid-autumn festival, or something that shows how the Vietnamese celebrate New Year by cooking New Year cakes, putting money in red envelopes, having fire crackers, and so on. That could be added to the exhibits.

Not many Vietnamese visit the museum because they don't know about it. The admission fee is OK, because they need the money to run the place and pay for the exhibits, but many Vietnamese think it's not necessary, not important.

Ms Dinh raised many of the same themes in describing what she saw as barriers:

The location is very difficult to access, especially because the Vietnamese community isn't familiar with downtown San Jose. Also, driving in downtown San Jose is scary: you worry that you'll get lost, or go the wrong way on a one-way street, so I've had older parents and grandparents who didn't want to come without volunteers to pick them up. And the parking component is also confusing. People will say "We don't want to pay for parking – we're already paying a fee." So paying, and looking for parking is a barrier. Parking is such a big thing. And then it's confusing, you don't know where the entrance actually is. There's a big building but it's not even clear how to get in. And they see the admission fee as really high. So at the workshops we try to communicate that you can't offer this to your children at home, your children will experience the world in a whole different way. And the money isn't too bad, given how much they will gain. But they look at it as a movie ticket. And there still has to be a lot of outreach, like media campaigns, for them to know it even exists. … So the experience with the museum is still new to them. And the idea that it's an interactive museum is something they don't understand until they see it.

[Interviewer: Would you have any advice for CDM going forward?] To continue the advertising. Vietnamese radio and TV channels are important outreach channels, and Catholic churches as well as Buddhist temples. Build partnerships with them, to do

> outreach with their communities. Also do events that target the community to come in and enjoy the museum on that day. For example, there was a circus event that had a Vietnamese component, and the Fairies and Dragons exhibition was amazing, and people got a lot out of that. And they wanted to come back afterwards.

It is worth noting that none of these families had been to the museum previously, so none had been to Vietnamese events or seen the recent *Dragons and Fairies* exhibition that had showcased many of these aspects of Vietnamese culture in a much more explicit way. None of the families mentioned having heard about this exhibition, but Ms Dinh remembered it fondly:

> I miss Fairies and Dragons. It was very different: everything was Vietnamese, the house, the beds, the motorcycle, everything. That exhibit was amazing. And that would attract more folks. This one (*Secrets of Circles)* has a much more limited emphasis on Vietnamese culture… If they were coming to get an enriching experience on their culture, they would need a lot more.
>
> This is hard work: it's a difficult community to outreach to, and even when you get them here, it's hard to get them to keep coming back. I really appreciate what CDM is doing…I really hope people will come to realize how worthwhile it is, so I keep my fingers crossed that all this work will bring out the community.

—

The Exhibition's Impact on Mexican-Descent/Latino Families (at Children's Discovery Museum of San Jose)

Background

As described earlier in this report, the Secrets of Circles exhibition was designed not only to help children learn about circles, but to reach out to two particular audiences: Latino and Vietnamese.

The original hope was that the general weekend / holiday audience would include enough Latino and Vietnamese visitors to be able to distinguish among them as target subgroups. In other words, it was hoped that the regular tracking and timing study, adult interviews, and children's interviews would include significant numbers of both Latino and Vietnamese visitors.

In practice, the number of Vietnamese families was so low (even with the help of a special invitation day organized by CDM) that a new study was designed to interview a small number of families in depth, by special invitation (reported in the previous section).

The number of Latino families in the regular weekend audience was around 10%, so their data could be reported and compared (though not statistically) with that of the non-Latino regular weekend audience (Section 1 below). In addition, CDM held a special Latino community event during one weekend of the data collection period, so this allowed for collection of a small amount of additional data about a slightly different audience (Section 2 below).

1. LATINO FAMILIES IN REGULAR WEEKEND MUSEUM AUDIENCE

Evaluation studies with the general audience revealed a lower-than-expected[23] percentage of Latino visitors:

- In the tracking and timing study, only ~1% of visitors tracked (or their caregivers) said they spoke Spanish at home.[24] (They were not additionally asked for their self-identified ethnicity, because of time restrictions.)
- In the interviews with children, 3% of the children (or their caregivers) said they spoke Spanish at home. When asked how they would describe their ethnic origin or nationality, 6% said they were Hispanic (or Hispanic as well as white or Asian), while a further 1% self-identified as Mexican, and 1% as Latino.

[23] CDM staff had anticipated that approximately 20% of the regular audience would be Latino.

[24] The observer noted that several families were overheard speaking Spanish in the gallery, but when asked, said they spoke only English at home. It may be that some families have a sensitivity to admitting they speak Spanish at home, particularly given California's recent political pressures on residents to speak English.

• In the interviews with adults, 8% said they spoke Spanish at home. When asked how they would describe their ethnic origin or nationality, 2% said they were Hispanic, 4% said Mexican, and none as Latino. If pooled together, this group constituted 10% of the total sample of adults interviewed.

Because of the low numbers of Latino families, it was not possible to conduct any kind of statistical comparisons among Latino and non-Latino families in the sample from the general audience, nor to draw any general conclusions about differences. Instead, the data was searched qualitatively for any responses that at least might suggest a potential difference between the Latino and non-Latino families in the general audience. These are highlighted below.

a) Children's interviews showed no differences.

Overall there were 8 children who spoke Spanish at home, or whose care-givers identified them as Latino, Mexican, or Hispanic. Their responses to the children's interview questions (Appendix E) were indistinguishable from those of other children. Further, they did not mention anything that the evaluator could recognize as culturally specific and relevant to the exhibition, though again, this may be because the numbers were so small, or possibly because the non-Latino evaluator who analyzed the data may have missed culturally significant nuances in their responses.

b) Adults' interviews showed unanimous support for multilingual labels.

Pooling visitors who said they spoke Spanish at home, or who self-identified as Latino, Mexican, or Hispanic, there were 11 adults in total, or 10% of the sample interviewed.

When asked what they thought of the labels in three languages, all 11 of these adults (100%) gave immediate positive responses, by contrast with 53% of the non-Latino adults interviewed. Their comments were:

> It's nice.
> That it's good.
> I really liked that.
> Good for people that can't speak English.
> Excellent that it caters to different groups.
> It's a good idea, we figured it out.
> Good.
> It's good, all kinds of people come.
> It's great, my daughters are learning Spanish.
> It's great, our family is bilingual.
> It's nice, they should have more languages.

Unsurprisingly, these adults were also unanimous in suggesting that CDM provide labels in English as well as other languages, but in this respect they were not very different from the rest of the interviewed sample.

2. LATINO FAMILIES AT COMMUNITY EVENT

Participants

Participants in the community event were adults and children who had come for the Three Kings Celebration (Tres Reyes), a well-attended two-day celebration of music, dance, art, culture, and performance that dominated the museum's public space on January 6-7, 2007. This is an annual event held at the museum, and brings in an audience with a much higher percentage of Spanish speakers than the regular weekend or holiday audience.

Over the course of the two days, 16 adults and 14 children were interviewed using the same bilingual interviews as given to the regular weekend audience (Appendices D and E).

Adults

The adults all gave Spanish as a language they speak at home; 5 of the 16 also gave English as a home language. Most (12 of 16) self-identified as Mexican; two described themselves as Hispanic, one as Latina, and one as white. The adults were all local to Northern California, with 13 of the 16 from the city of San Jose. They were less likely to be regular visitor to CDM than regular weekend visitors: 50% had been to the museum before (compared with 70% of regular weekend audience), and only 6% were members (compared with 50% of the regular weekend audience). Most were female (81%, versus 56% of regular weekend audience adults), though their ages were similar to those of regular weekend groups, with most parents in the 26-45 range, and the median group size of 4 people was the same as on regular weekends.

a) Adults were less likely to recognize Circles theme.

Compared with data from the regular weekend audience, the Three Kings audience was less likely to identify Circles as the exhibition theme (50% versus 85%, $chisq(1)=10.9$, $p<0.001$). There may be many reasons for this, including: (i) The families may have had less prior experience in museums and might not have expected a collection of exhibits to have a theme; (ii) the families may have been in a hurry because their main focus was on the performances happening outside the gallery; (iii) the extreme crowdedness and high noise levels probably made it difficult to move easily through the space, or to focus on reading labels, which apparently carried much of the message of the exhibition theme (as previously described).

b) Adults were less likely to notice labels but more positive when they did.

Fewer adults in the Three Kings audience noticed the trilingual labels (81% versus 94% for the regular audience, chisq(1)=3.54, p=0.060). This may be due to many factors, but seems likely to be at least partly due to the extreme crowdedness of the museum and the preoccupation of families with their dance performances.

However, those adults who did notice the labels were more likely to be positive in their reaction (92% versus 65%, chisq(1)=3.87, p=0.049). Their full set of responses were as follows:

> They are easier to understand when they are in many languages.
> Good, people who speak Spanish could read. For me, I didn't really understand the English part, but when I read the Spanish part it became clearer.
> Useful, good guides.
> We liked it.
> Good.
> It's good.
> It's nice.
> It's good, that way we understand everything that it says.
> It's good because the people that speak English can read in English and the people that speak Spanish can read in Spanish.
> It's good.
> Very good.
> I think it's fabulous because it exposes children to different languages and cultures.
> Three languages.

Their positive responses mimic those of the Latino families in the regular weekend audience. Unsurprisingly, these adults also unanimously recommended that CDM create labels in English as well as other languages. Some commented:

> Many people come [to the museum] that need their language [on signs].
> People speak different languages.
> We want our kids to be bilingual- more multi-cultural.
> [They should have] English and Spanish.
> It's good for them to be in other languages.
> Various languages.
> In English a little bit.
> A lot of languages.

One person added that her child had learned something specific because of the multilingual labels:

> He just associated “circles” with the Spanish word “circulos.”

Overall, the fact that the Three Kings adults were marginally less likely to notice the labels, combined with the finding that they were less likely to notice the Circles theme, reinforces the conclusion from the overall adult interviews that the labels were key carriers of thematic content in this exhibition.

c) Adults made as many personal connections

Even though the overall theme of the exhibition was less obvious to the Three Kings audience, they were just as able to name specific connections to their own lives as the regular weekend audience (Three Kings 63%, regular 54%). Perhaps this reflects the ability of individual elements in the exhibition to connect to people's daily lives, even if the overall theme is less obvious.

d) Adults responded to the design similarly to the regular audience

Adults in the Three Kings audience responded to the exhibition's design in a similar way to adults from the regular weekend audience. They had slightly more positive responses to the design overall (63% positive comments versus 50% for regular audience) and the use of color (25% versus 15%), but these differences were not statistically significant.

Children

During the Three Kings Celebration, 14 children were interviewed, using the same questions as were given to children on regular weekends (Appendix E). Their responses showed no significant differences when compared with those of children on regular weekends, and are thus not reported in detail. It may be that differences were not obvious because of the small sample size, although large differences would have been apparent, even with N=14 children.

Secrets of Circles Family Science Night Program

Background

As part of the *Secrets of Circles* project, the Children's Discovery Museum developed a set of materials and activities to be part of their Family Science Nights. The Museum has been offering these nights to local elementary schools for over ten years, and the *Secrets of Circles* project gave them an opportunity to create a set of materials and activities on the Circles theme.

The lead evaluator visited one school during their Secretes of Circles Family Science Night, and her observations are presented in this section as a short case study.

Purpose

The questions guiding this study were:

a) How did the Family Science Night work logistically?
b) How did the teachers respond to the event?
c) How did the parents and children respond to the event?
d) Was there any evidence of learning, particularly of math or science? How did participants think this kind of learning compared with that in the school's classrooms?

Methods

The evaluator visited an elementary school that was hosting CDM staff for their annual Family Science Night on January 18, 2007. Throughout the event the evaluator moved among the teachers, parents, and children, and interviewed them individually or in small groups about what they were doing, what they thought about the event, what they felt was being learned and how it differed from school more generally. Interviews were open-ended, and typically about five minutes in duration.

Participating School

The studied Family Science Night took place at Dilworth Elementary School in west San Jose. This public school serves K-5 children, and is a neighborhood school, meaning that only those living in the local neighborhood can attend. The school community is a diverse representation of middle and upper socioeconomic levels, and most parents work in professional and semiprofessional occupations. Several teachers proudly mentioned that the school was scoring "fifth in the state" in standardized tests, and the school's California Standards Test (CST) results show 83% of students achieved at the Proficient or Advanced level in science in 2006. CDM staff noted that the school is the largest in terms of

participation that they visit during the course of the year. Overall this school probably represents a "best case" host of the event.

Summary of Findings

Overall, the Secrets of Circles Family Science Night was highly successful in terms of attendance, logistics, teacher participation, and enthusiasm from all participants. There seemed to be significant amounts of conversation about the Circle-themed activities, and some of the children showed impressive facility at understanding both the physical and conceptual aspects of what they were doing. Finally, the model of pre-event teacher training worked extremely well in this case, with full and enthusiastic participation by the teachers, who were then able to expertly facilitate children's learning activities with the help of the well-designed and documented materials from CDM.

Detailed Findings

a) How well did the Family Science Night work logistically?

The event was held in the school's general assembly area, a large indoor space next to the library. CDM's Museum Outreach Educator, Karen Peck, and her team arrived at 5.00 pm in a minivan with the materials packed in large plastic tubs, and laid out the contents on the school's large tables. At 5.30 pm they held a short training for the teachers and other volunteers who had offered to staff the tables when the families arrived at 6.30 pm. During the training, the CDM staff introduced themselves and the evening's theme of Circles, demonstrated each of the ten activities (one per table) and answered questions, before letting the teachers (and a few additional volunteers) explore them and become familiar with the one they were going to facilitate that evening. Each activity was accompanied by materials for construction or exploration, extra materials in the plastic tub under the table, and a one-page sheet of key instructions and any underlying mathematical ideas behind the activity. Approximately half of the activities were "take-aways," in which children created something they could take home with them, such as a spinning top constructed from a CD. Anyone was welcome to attend the event, so families could bring their friends with them, even if they did not attend the school. Participants were asked to give a donation of $5 to help offset the cost of $925 paid by the school.

Logistically, the event ran extremely smoothly, presumably reflecting the quality of the program and materials as well as the long history the school had with hosting the event. All parties arrived on time and understood their roles in the event. The activities engaged children of different ages, and the area had an overall feel of high energy and boisterous social connection, combined with pockets of concentrated engagement by children working on activities. A large fraction of the family audience came at the beginning of the event and stayed until the end, and many people helped to tidy and clean up. Overall, there was a spirit of joyful participation and community commitment that was impressive to observe.

The only suggestion made for improving the event's logistics was one teacher's proposal to extend the hours of the event to make it day-long (or split over two successive evenings), with different grades at different times, to make it less crowded.

b) How did the teachers respond to the event?

The fifteen participating teachers were enthusiastic and involved in the event. They were all volunteering their time, yet nobody seemed resentful, and there were so many teachers that there hadn't even been a need to call for volunteers to staff any of the tables. The teachers seemed to feel that their commitment was nothing out of the ordinary:

> It's a tradition here to have Family Science Nights. We have a really small staff, so we all sign up. They have 15 spots and we have 20 teachers, and we fill 'em. [First-grade teacher]
>
> We volunteer our time. It's fun. [Third grade teacher]
>
> I come every year, just for the interaction with the kids, seeing their creativity… Last year the museum came did one on microscopes. And there was one on food coloring, how you can spin it and it separates out into primary colors. I get to meet the kids, especially the good ones she talks about! [Volunteer, teacher's partner who came with her]

The teachers seemed to particularly value the hands-on aspect of the activities. Several said that the school did already try to include hands-on activities in the classrooms, but that these were not enough.

> We try to do hands-on activities in class too. But this is more focused, or maybe it's that it has more resources. And things we haven't thought of, like making tops out of CD's, I would never have thought of that. [First-grade teacher]
>
> A lot of the kids couldn't have such a rich hands-on experience unless it was offered. We do a lot of hands-on things, and the district provides a kit, but this is in addition. [Kindergarten teacher]
>
> For so many of them, school is about textbooks; there's not enough hands-on activity. [Third grade teacher]

Many of the teachers also appreciated the relaxed social situation in which parents, children, and teachers could talk together, and make community connections:

> I love seeing the kids outside school. I'm always "Miss X," but now I get to play with them. [First-grade teacher]
>
> It's the parents and students coming together to school. The kids think they're playing, but the parents know they're learning something. Plus they get to meet their friends, and see their teachers outside of school… It's good for them to be socialized too: They can talk about what they had for dinner. [first-grade teacher]
>
> This is a tight-knit community, with lots of support. And the Family Science Night is organized, and has easy setup, and it brings the community in. We have lots of

families from India, and China, and income isn't so much of a factor. We're fifth in the state. [Kindergarten teacher]

We don't do many all-school events like this. Parents just love it. And children just love it. [second-grade teacher]

Teachers also appreciated fact that that there was no enforced structure, and no academic pressure to cover a curriculum in a certain time, allowing the children to explore in comfort:

They don't have to "keep up." It's not focused on academic achievement… They don't have to be done in ten minutes; it's a friendly environment… I want them to get a little bit out of it too, but mostly I want them to explore. [First-grade teacher]

Lots of kids have structured things to do: violin lessons, that sort of thing. So this is fun. They don't have to look at a textbook and write equations. [Third grade teacher]

The best thing the kids get out of it is the freedom to explore and be creative. [teacher, grade not recorded]

We used to have such creative units, but they take a week to do, so we can't do them any more because you just have to keep working to get through the standards stuff. [second-grade teacher]

One striking observation was the ease and speed with which the teachers learned to use the materials in the activities. Not only could they demonstrate their function and underlying principle, but they were facile at adjusting their mediation to suit the age and confidence level of the child working with them. For example, a teacher staffing a table with gears engaged with a young boy without any lecturing:

Boy: What do you do?
Teacher: Just make gears.
Boy: [puts a gear in place, makes it turn.]
Teacher: Which one do you think will go fastest – small or big?
Boy: Big.
Teacher: OK, try it.
Boy: [tries it.]
Teacher: Good job!
Teacher: You can add more.
Boy: [adds more gears].

[later, interviewer talks with teacher:]
Interviewer: How do you change what you say to children of different ages?
Teacher: If I'm talking to a first-grader, I'll ask "which will be faster?" but if I'm talking with a higher grade child, I'll say "how MUCH faster, like does the smaller one go a quarter way around? Can you do it with the dots? "
Interviewer: How do you figure this out so quickly?
Teacher: [laughs] Oh, the directions help.

Several other teachers also referred to the usefulness of the one-page instructional / explanatory text that came with each activity. It seemed that these were written clearly and were immediately useful to the teachers without being too long to read.

c) How did the parents and children respond to the event?

Parents and children interviewed were very enthusiastic about the event. Most had been to Family Science Nights in previous years:

> We LOVE this. Every year we come. My kids were here at 6.05, even though it only starts at 6.30. [Interviewer: But it's cold outside tonight.] Yes, but we wanted to be here when the doors opened.
> My son has a bad headache, but doesn't want to miss it.
> My son was quite enthusiastic to come here. He was a little confused at first, but finally he found a place over there at that table.
> It's really cool, very interesting. And it's different from the past two years, so it keeps changing, which is good. The kids say "We want to go to Science Night." We come for all the events.
> It's all about the kids. They're having fun.
>
> It's really really fun. There are lots of activities. [5th-grade girl]
> This is my first time, I'm new. I wanted to see what this was. I like to do the activities. I just get to play and do activities and there's fun stuff to do. [3rd-grade girl]

Parents' comments echoed those of the teachers, in their valuing of children's opportunities to explore hands-on activities of their own choosing and at their own pace, in a relaxed social environment:

> No kid is giving up. They just take their own time.
> My son is here, building a bridge, and my daughter likes the coloring and circle things; every child has something they do. They get to see the teachers here, so they go to their favorite teachers first. But they do every table because there's plenty of time, unless it's really crowded. [parent]
> He loves all kinds of puzzles or lego or anything.
> I want my son to come and see what it is and do what it is. They have lots of these activities, and the kids are very enthusiastic. They want to come and do different experiments, do new things.
> There are different concepts in each experiment. They get to do things on their own.

Also, like the teachers, several parents talked about the high quality of the school, and appreciated the opportunity to meet with others in the school community:

> I know some of the other parents here, and it's a nice opportunity to meet other parents outside the school. Usually you just meet them in the school.

This time the teachers are doing everything on their own – there aren't even any volunteers. It's amazing.

This is one of the best neighborhood schools in the district. Lots of parents also volunteer – I used to before I had the kids.

It's a neighborhood school, so we all live around the neighborhood. The parents play a very active role in the school – you can see from the participation: you can't even get to the stuff!

We came here from Northern India. We had to choose between a public versus a private school, and I chose public, but looked for one with a good reputation. This one builds a strong community.

d) Was there any evidence of learning, particularly of math or science? How did participants think this kind of learning compared with that in the school's classrooms?

Interviews with children suggested that they were impressively adept at figuring out both what to do and what the mathematical or science-related principle behind each activity was:

Interview with 4th-grade girl (aged 10):

[The girl is doing an activity where different shapes are rolled in ways that leave a trace of their path.]

Interviewer: What do you do here?

Girl: Take off the cap, and then you roll it along and see which one's the smoothest. It's obviously clear that the circle is easiest and the oval is next easiest. The round ones are always easier. The triangle isn't easy, but it's OK, and the least easy is the square, for obvious reasons. The star is weird because of all the points; the points make it hard.

Interviewer: Is there something you're supposed to learn from this?

Girl: It shows why wheels are circles, because it's much easier than any other shape.

Interview with 5th-grade girl and boy:

[They are doing an activity that compares how many dried peas will fit into two pieces of paper folded into cylinders with a triangular versus circular cross-section.]

Interviewer: Which do you think will hold the most?

Girl: It looks like this one holds more space [predicts the cylinder, correctly]

Interviewer: How do you know it's that one?

Girl: Often they trick you, when they ask a question, it's not what you first think.

Boy chimes in: I think it's this one [also predicts cylinder, correctly] because a circle can surround everything. [He tries to prove his point by dropping the cylinder over the triangular prism, but actually it doesn't work because the cylinder has the same circumference as the triangle's total side length. But he doesn't seem daunted – just treats it as a technical hitch.]… Round stuff has more capacity. And it can fit over it. That was… three-quarters of a cup. I already know this stuff: I studied it in the 4th grade.

Interview with 3rd-grade girl:
Interviewer: How does it work? What do you do?
Girl: You do this, connect them together, use the tape to stick it, and get a paper, and try to make a circle. [She expertly demonstrates the steps to construct compasses from wood, tape, metal rings, safety pins.]
Interviewer: Is there a way you could make a smaller circle?
Girl: Yes, you could take off one of these [she does, perfectly]. And then you could estimate how wide it is, and then take a ruler, and this one is five inches.

While children tended to initiate activities, and most worked alone or with their friends, there were also many parents who stood close to their children, supporting them with suggestions or pointing out the mathematic significance of what their children were doing.

Observation of mother with boy who just completed assembly of an arch bridge:
Mother: Asian people built like this – it's very strong. Nowadays they put pillars here to support it, but before they had that, Asian people built it this same way.

Observation of boy with mother:
[Boy is doing the activity where plastic pie-shaped pieces represent fractions of a circle.]
Mother: These black ones are finished, so you have to find more.
Boy: [in a creative solution, finds a purple piece to fill the void and complete the circle:] I made the circles!
Explanation from mother to interviewer:
It's very good for kids. They can learn. He's five. He knows circles in different ways, like how many pieces go into a circle. And I heard the teacher ask him "Why do different numbers of pieces make the circle?" And he said, "Because these are small, so you need more. " It's very good.

It seemed to the interviewer that there was a good deal of productive mathematical and science-related conversation embedded in the joint activity that was loosely shared by children, parents, friends, and teachers.

There was also evidence that the circles theme was relevant to teachers' agendas and that the event provided them with ideas to enrich their own teaching in the future:

Circles are of interest to primary grades, and geometry is relevant for 4th and 5th grade too. It gives you different ways of looking at the topic than the textbook. [second-grade teacher]
This was different in that it revolves around a central theme. I teach kindergarten, and we're growing our own crystals, and the bubble activity fits with that – it's all the same idea… We do a math unit on patterns and symmetries, so it's very basic but this goes to their level…This is so simple. I wouldn't have thought to do it, but now I know, we can do this as an experiment in our own back yards. [Kindergarten teacher]

When asked to reflect on the learning they thought was happening, and how it differed from classroom-based learning, participants talked about the value of access to a variety of hands-on experiences, of having fun, of exploring in a social setting – typical features of learning in informal settings.

> It's not reading books. It's more interesting to do activities. You're learning but you're allowed to talk, and be with your friends. We also do hands-on things, but we have to read out of books. [Interviewer: You don't like reading?] I do, but sometimes in science it's better to do hands-on things and actually learn. And I enjoy working alone, and in class we have to work in groups a lot. Plus there's a limit to what you learn in school, but here you can learn as much as you want. Like if you want to experiment yourself, you can try it in other ways too. And here you have more time. It's nice to be with your friends but doing your own thing. [5th-grade girl]
>
> All these toys they're exploring, they don't get in a regular classroom. [parent]
>
> It's not competitive exactly, but more kids together makes an event, instead of school. [parent]
>
> I don't know how much of this he gets at school, actually. Here he has the practical aspect of whatever you're trying to demonstrate. Here is seems mostly physics. Last year it was biological. So there's a nice balance between physics, chemistry, and biology. [parent]
>
> It would be hard to make it more academic, because there are so many kids here and they're all running around. But I like it the way it is, anyway. [Third grade teacher]

Two people mentioned that the experiences could be remarkably memorable for the children over time:

> Sometimes the kids will say, weeks later, "Remember how we made it in the Science Night." Like last year there was a spinning thing, and she remembered a long time later, when I'd forgotten. [parent]
>
> Maybe the kids wouldn't understand all the complexity, but we'll hear about it for the rest of the year… They'll look at the activity with the cars with the different wheels, and they'll say: "What do you think it'll look like with triangular wheels – I bet I know." Without this experience it wouldn't enrich them to make those connections. Their experience has to come from somewhere, and this is great. [Kindergarten teacher]

And several people named ways that the activities encouraged cognitive aspects of learning:

> Some of it is logical thinking, like building a bridge you have to figure out where it goes. [parent]
>
> In that activity where they were folding over the paper to make a pattern, there was some reasoning there, about where to fold, and how may folds, to make the mandala. [teacher]
>
> I learned that there's so many fun exciting things about circles. [5th-grade girl.]

Interview with 5th-grade girl:
Interviewer: Do you think you learn anything from doing these things?
Girl: Your mind gets sharper.
Interviewer: How is it sharper?
Girl: You figure out how to hold up something without it falling. Or you figure out stuff you'd never have thought of.

While most parents interviewed seemed satisfied with their children having enjoyable hands-on experiences, two expressed a wish for more help identifying the concepts behind the activities:

I didn't see any documentation to demonstrate the idea behind the activity. What does it demonstrate? Maybe you could have "friction" or "gravity" or whatever, as a heading. Maybe a banner at the end of each table, to connect it to the curriculum, and then people come and see the banner, and they know what it's supposed to demonstrate. [Interviewer: There's a one-page summary somewhere, of the principles behind it.] I know, but you can't find it easily in the crowd. So I don't know what he's learning exactly. [parent]

I haven't been to all the tables, so I don't know. But here's one about gears, big and small, and how fast they move. But parents have to explain the concept, or they think it's a toy. I explain where I can, but it's not always that I know. [parent]

What factors contributed to the overall success of this event?

Because this was descriptive case study of a single event with a single school, one can only speculate about the factors that accounted for its apparent success. However, it seemed to the evaluator that the following may have contributed:

- The school was community-spirited and parent involvement is high;
- The teachers were dedicated and experienced.;
- The materials and activities provided by CDM were well-designed, age-appropriate, and had effective supporting materials.
- The setup and training were well organized.
- Children who attended the event arrived with economic, educational, and cultural advantages that allowed them to take full advantage of the event;
- Children and their parents both appreciated the value of informal, hands-on learning.

Unfortunately it was not possible to observe *Secrets of Circles* Family Science Nights at other schools within the timeframe of this study, but the event at Dilworth Elementary at least serves as an inspiring example of what this *Secrets of Circles* program could achieve under ideal circumstances.

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Secrets of Circles Traveling Exhibition at Two Remote Sites

Background

One of the key dissemination strategies for the *Secrets of Circles* project was a traveling exhibition, essentially a copy of the permanent CDM exhibition that is described in this report. Since it was not feasible to replicate the full tracking and interview studies at the remote sites, the project team and evaluator felt that the most useful way to gain insights for the museum field would be to conduct in-depth interviews with museum staff at these sites, asking them for their perceptions of the exhibition's use and impact on their institutions and visitors.

Purpose

The staff interviews addressed the following questions:

a) *How well did the museum travel, from the logistical perspective?*
b) *How did visitors at the two remote sites respond to the exhibition?*
c) *Did the exhibition reach a broad audience at the remote sites?*
d) *How did other sites respond to the geometrical theme of the exhibition?*
e) *How easily could staff create related programs to support the exhibition at their sites?*
f) *Were the supporting materials and activity guides helpful to the staff at the remote sites?*
g) *How were the multicultural components of the exhibition received, particularly at sites that did not have a significant Vietnamese community?*
h) *Did the exhibition inspire any kind of multicultural outreach on the part of the host organizations?*

Participants

Participants were staff members at the first two venues for the *Secrets of Circles* traveling exhibition:

(i) Strong National Museum of Play in Rochester, New York.
With approximately 500,000 visitors (guests) annually, Strong identifies itself as the first and only major museum in the world devoted to the study and interpretation of play. It is also the second-largest children's museum in the United States and one of the largest history museums. The museum recently completed a major expansion. More details can be found at http://www.strongmuseum.org.

Strong Museum hosted the exhibition from Feb 17 – May 6, 2007. During this time it was visited by an estimated 140,000 people, including 11,000 school students on field trips.

(ii) Ecotarium in Worcester, Massachusetts.
With an annual visitation of 112,000, this private non-profit has its historical roots in the natural sciences, but has extended its mission to focus on hands-on exploration and discovery. It includes exhibits, a discovery room, live animals, and extensive nature trails. More details can be found at http://www.ecotarium.org.

The Ecotarium hosted the exhibition from May 22 - Sept 9, 2007.

Methods

Staff were contacted by the lead evaluator via email or phone and asked if they would be willing to talk about their experience with the *Secrets of Circles* exhibition. If it was appropriate and desired, the staff members were sent the list of interview questions ahead of time; however, in many cases staff members had only been peripherally involved in the project, and they were not sent the list of questions, but were interviewed more spontaneously. Appendix I lists the questions that guided the interviews.

In all, four staff members at Strong were interviewed, and six staff members at the Ecotarium. The staff at both host organizations were extremely accommodating in answering the evaluation questions, and seemed quite candid in their responses (which was explicitly requested by the evaluator).

As requested by one participant, all names and positions have been excluded from this report and from the transcripts, and only the institutions are named. All participants were comfortable with having their words quoted in this report.

One of the organizations also completed an evaluation form designed by CDM. This was used to provide information supplementary to the interviews.

Summary of Findings

Overall, staff gauged the response of visitors to the exhibition as positive. Perhaps the single most frequent comment, particularly from Ecotarium staff, was their pleasant surprise at discovering that the exhibition worked for a broad range of ages. It was seen as a lively and varied space that encouraged collaboration between adults and children (apparently echoing the shared interactions and talk observed in the regular CDM audience). Only the school audience was unresponsive to a Circles-related program, for reasons that are not clear.

Staff said that they saw the trilingual labels as adding value to the exhibition, had observed visitors using the Spanish labels, and were willing to explain the choice of Vietnamese to visitors who were puzzled. One institution used the exhibition as a catalyst to involve the local Spanish-speaking community in co-creating a large and successful public event at their site.

Installation of the traveling exhibition in remote sites was made relatively easy by the flexible design, custom-made crates and use of castors. Lighting and maintenance challenges were solvable, although a few exhibits had safety issues, especially with older children who readily engaged with it. The marketing and educational materials that accompanied the exhibition were used by staff at the remote sites, often modified to fit their needs. Some frustrations were reported related to marketing materials.

Detailed Findings

a) How well did the museum travel, from the logistical perspective?

Installation staff at both sites commented that the exhibition was well made compared with others they had worked with:

> This one was particularly well made. I know that one aspect of the way CDM developers create the exhibit is that the designer sees it through to completion, which is a great way to do it. And different exhibit developers used different kinds of bolts, so there was some kind of learning curve on each interactive, but I have only glowing things to say about how the exhibit was put together… I know that part of CDM's development process is to have many of the elements on the floor at CDM for about a year, so lots of the bugs had already been worked out. [Strong]

The custom-designed crates also facilitated installation, though with the acknowledged downside that they were difficult to store.

> Custom crates like this one makes my job easier, because all the pieces for component A are in the component A crate. So for each component, all the pieces got strapped to the crate. So the crate cannot be taken apart. And it's obvious where things go. So it's great for me, but a headache for maintenance staff, because the crates don't break down, so you need two trucks of storage space. And having that armature in there, you couldn't even put smaller crates in bigger ones. So someone has to store all the empty boxes, and many venues taking a 3,000 sq ft exhibit can't store that much…We knew enough ahead of time that we could arrange for donation and rental of storage. [Ecotarium]

Staff particularly appreciated the castors, and the overall flexibility of design:

> It's always better when things are on wheels. I've had heavier things than the components of *Circles*, and they arrive without wheels, and that makes it really difficult. [Ecotarium]

> With the castors it was easy to unpack and set up, done in a thoughtful fashion… *Circles* went together really nicely, and the instructions were well written. [Strong]

> Our gallery is trapezoidal in shape, and the benches gave flexibility to the design. [Strong]

There were some challenges in getting spaces dark enough to display the exhibits with fluorescent displays, but these were resolved satisfactorily:

> In terms of lighting, I ran around with the lift and made sure the space was dark enough where it needed to be. The big umbrellas seemed to work well, and gave it some drama too, in the sense that it just wasn't evenly lit like many of our exhibits are. [Strong]

> Like CDM we have a giant glass wall, so it's not great for light-sensitive exhibits, but there was communication ahead of time, so we knew to put those at the back. [Ecotarium]

Clearly there were ongoing maintenance needs, exacerbated by the exhibition's heavy use by a variety of audiences. Most staff described these as expected from normal wear and tear, though some staff at Strong found it too much:

> It's been very well received. Loved to death, even. We've given it the high-humidity test. A few glues failed, but that's all, and people have been really hard on it. [Ecotarium]

> We're blessed here with incredible attendance. So in four months we broke things that would probably have lasted a year at CDM…But we get a lot of people, and the numbers generate excitement that seems to grow exponentially. [Strong]

A few exhibits raised safety concerns and two had to be adjusted or even taken off the floor, again seemingly in response to the high levels of audience engagement:

> We had to make the Giant Tire not move, because it was a big problem with the summer camps in particular: there'd be lots of kids and not many adults, and they'd get the tire going really fast and then someone would get their arm caught. They had lots of fun of course, but it was a safety issue. [Ecotarium]

> And Build an Arch we were also unable to use; we didn't even open with that on the floor. [Strong]

> Safety: The paddles in the boat had some occasional issues: they were splintery, or kids were hitting each other with them. [Ecotarium]

b) How did visitors at the two remote sites respond to the exhibition?

Neither of the two hosting institutions conducted any kind of formal or systematic evaluation of the exhibit or associated programs, but the staff drew conclusions about the impact of *Secrets of Circles* based on their own observations and interactions with the public.

The staff thought their visitors had appreciated a variety of aspects of the exhibition:

> They really liked the general aesthetics, the way it looked: lots of color is a good thing with kids, and the dress-up clothes, and we have an environmentally conscious audience, who really liked the bamboo being a renewable resource. [Ecotarium]

> We have a preschool program every Wednesday, and they were really into it: the bright colors, the dress-up stuff, made it popular with that age. In terms of the hands-on exhibits, I would often see people trying to balance the wheels on the turntable [On a Roll], and also using the one with the camera [Spin Pictures], those were quite popular. [Ecotarium]

Many commented on the high levels of engagement of their visitors. For example:

> I thought it was much more engaging when I watched our guests using it than I thought it was going to be based on looking at the photos and online stuff. We even had an incident where a young man got in the tire and wouldn't leave: He said it was his home and he wouldn't come out! We did finally get him out, but it took about two hours, and in the end we had to bribe him with a free pass. He just found it comfy, cozy, he felt at home. [Ecotarium]

> *Circles* was really hopping all the time: a nice level and quality of noise, a physical part of interacting with it, like when you pull the cinder blocks [Inventing the Wheel] and also the Gears, where people didn't want to leave until they'd solved it all, and the intergenerational aspect, and the fact that it's so physically engaging. [Ecotarium]

Another theme was that the exhibition engaged children, but also seemed to encourage collaboration between adults and children:

> I thought it was a good combination of what kids could do on their own and what they could do with the help of an adult. For example, the element where they build a bridge and then pull out the form afterwards [Build an Arch]. Kids had some difficulty with that concept – they tended to leave the form in, but when I watched adults interact with them, and try to explain to them, it became pretty powerful. And the spinning table [On a Roll] was also something that engaged people in different ways to see how things interacted with the spinning table, whether it be a ball or one of the disks that came with it. [Ecotarium]

> There was enough there that kids could do on their own, but also parts that could engage the whole family. For instance, the one where you pull the bricks [Inventing

> the Wheel], that was one that kids could do and understand by themselves. And the round boat the kids could do – get in there, have fun, fire up their own imaginations. Whereas Gears, for instance, took more parent involvement to drive the gears at the back with the ones at the front. So did building the bridge. And the one with the spinning table [On a Roll] had both: kids could have fun themselves, but parents added a dynamic to it. [Ecotarium]
>
> It really seems to encourage good cooperative play with (between?) parents and kids. [Ecotarium]

Staff also offered detailed reflections on a number of the elements in the exhibition, describing their strengths in engaging visitors, and identifying problems and possible improvements. These are listed in Appendix L.

Lastly, there were a few spontaneous comments about the look and feel of the exhibit:

> The wood carvings, and the use of natural materials: it was nice on that level. [Strong]
>
> I liked how you had a least one bench that matched everything else, a nice wooden bench. It gave people the chance to have a little down time; they could sit there and relax. I did some research on seniors, and having seating is a big issue for them. [Strong]

Overall, staff gauged the response of visitors to the exhibition as positive:

> I think it was a really fun exhibit and our audience seemed to enjoy it a lot. A lot came back again to play some more and didn't realize it was temporary, and they were kind of sad. It definitely met our expectations. [Ecotarium]
>
> It was a nice little exhibit, and we enjoyed having it. [Strong]
>
> Overall guest response was good but not great. [Strong]
>
> It turned out to be a really great addition to the museum. Our audience responded in a really positive way, compared with some others that we've had. [Ecotarium]
>
> It's just been very well received. [Ecotarium]

c) Did the exhibition reach a broad audience at the remote sites?

Perhaps the single most frequent comment, particularly from Ecotarium staff, was their pleasant surprise at discovering that the exhibition worked for a broad range of ages:

> Reading the materials, *Secrets of Circles* seemed designed for a very young audience. So we had some hesitation, but the quality sounded strong, so we went with it…But from the minute it arrived, we discovered that it was going to work for a much broader audience. One time…the local YMCA was using our facility, and they had a group of teens here that were part of our program. And you look over the railing, and here are all the teens in the boat! Really, they're all dressed up and sitting in the boat! And it continued in that vein: adults, teens, visitors of all ages, in a way we just never expected… So I guess it shows that everyone likes to play, and it's remarkably well designed for all ages. It stunned us that it had such a broad appeal. [Ecotarium]
>
> It really appealed to a broader age range than I'd expected. There was lots of family interaction, and even older school groups found it engaging enough to spend time with. [Ecotarium]
>
> Circles offered something for preschoolers to do, with lots of touching, feeling, and dressing up. Though actually it was well-received by all ages: one day there were business students from some college sitting in the boat all dressed up. [Ecotarium]
>
> We had lots of group participation: summer camps, different agencies, sometimes funded summer programs. [Ecotarium]
>
> This year, August was a good month for us, and … part of that was Circles-driven: people came in June and July, and then looked for a reason to come back again. [Ecotarium]
>
> It appealed to our general age range of 10 or 12 and younger. So it was appropriate, and it included some things for the older kids. [Strong]
>
> This exhibition doesn't scream "children's museum." Even though it's interactive, and hands-on, with plastic vegetables and try-on clothes. But because there are so many science museum hands-on interactives, it didn't even hint to a middle school or high school kid that this is babyish, not for you. And the colors were very inviting to a much broader age than a classic children's museum. We'd never be an audience for *Alice in Wonderland*, for instance. So the upside is: it has much broader appeal. [Ecotarium]

The inevitable disadvantage of having such energetic engagement by all ages, according to one Ecotarium staff member, was the higher frequency of maintenance and safety problems.

> The downside is: once you get outside of a children's museum audience, you expose your museum to the most destructive force on earth: the 8th-grader. Like with the

> Giant Tire, we had several cases of hand and arm entrapment, so in the end we bolted that down. Because when you're an 8th-grader, you're tall enough to rest your arm on top, and the kids inside don't see that, and they turn the tire, and it catches an arm or a hand. Eventually we just said we can't make it work. With littler children, it might have been very different. And part of the reason is the energy of the exhibition: With the spinning table and the bricks, you change the visitors' expectations of how to behave. They'll jump up and down, and pound on things, because that's how we've trained them to behave in a science museum. And there's the bridge, which is a large motor-skills thing. And bricks on a sled, takes hard pulling. Even the spinning table moves really fast. They're all classic science museum things, and there's no way to build a science exhibition that's bomb-proof, and this is pretty bombproof – you can't really do better. [Ecotarium]

Only one audience was mentioned by staff as not being engaged: school field trips. The Ecotarium had no experience with these, since *Secrets of Circles* was a summer exhibition at their site, but Strong staff reported:

> It didn't appear to be particularly popular with school groups especially since the rest of the building was recently expanded and is so compelling. Modular, borrowed exhibits look much different than Strong's own permanent exhibit installations and it's apparent to our guests, and they tend not to be as attracted to them. Strong is less reliant on borrowed exhibits than many other museums.

d) <u>How did other sites respond to the geometrical theme of the exhibition?</u>

The Ecotarium, in particular, embraced the geometrical theme of *Secrets of Circles* and its incorporation into physical science principles:

> We're trying to get away from natural science, because we've done such a lot of that, to have more emphasis on physical science. So it was good for us from that point of view. [Ecotarium]

> I always like to see some math in the science exhibits because people don't think of science as requiring math knowledge, but it does. So working it in there in an accessible way is beneficial. [Ecotarium]

Two people felt that the Circle theme had reached visitors:

> I didn't talk to visitors myself. All I saw was people having a blast. Parents reading the text to kids as they worked on it. I think the circles part came through.

> I think people did get that it was about circles. I had a mother come in and tell me that they would visit the Circles exhibit in the morning, and then they'd see how many circular objects they could find throughout the day. Not everyone got what was special

about circles, but they noticed there are circles around them everywhere, and the exhibit helped point that out. [Ecotarium]

Others were more skeptical of the salience of the Circle theme, but felt this was less important than the enjoyment or engagement aspects of the exhibition:

> I would say 25% probably recognized the theme, and the other 75% probably weren't involved with the science of circles. [Ecotarium]

> People didn't talk a whole lot about that. Lots commented they really enjoyed the color or hands-on things, but not a lot about what they thought they'd learned. [Ecotarium]

> They don't care what they're learning as long as there are interesting things to do. Having math in it, and component skills like motor skills or language arts, is a bonus, because then the parents say "Oh cool, they're learning something. "But nobody seemed to acknowledge it as being a math exhibit. [Strong]

Surprisingly, the school audience did not embrace the exhibition topic: Strong's monthly Theme Day had to be cancelled for lack of interest:

> We did offer one program called a Theme Day we where we invite up to 400 students from different venues, and that's usually a popular way to invite them in, based on different themes... This one was described as "Round and round. " I really don't know why they didn't come – it was unusual and quite sad. To me personally it seems such a great topic, and we have a lot of field trips that come here in regard to math – some of my top experiences are math-related, so that usually does draw attention. I don't know why. [Strong]

Perhaps the reason for this lack of interest had to do with teachers feeling intimidated by physical science, or possibly burned out:

> What we're hearing is that physics is a huge problem that shows up in school testing, and lower grade teachers don't get physics, so they have a hard time teaching it. So the city school system here is requesting that we do more on physics. But there's so much going on all the time in schools here, that if you aren't coordinating with that system at a high level, you don't know what's coming next or what's really going to stick, and the teachers tend to get fried with all the changing demands on them. [Ecotarium]

Alternatively, maybe the topic seemed too young to the invited school audiences – after all, Ecotarium staff had initially perceived the exhibition as appropriate for very young children:

> Maybe it seemed very much of a younger topic: We were targeting 2nd –4th graders, and maybe they felt they already know this: "We all know what a circle is; it's round." [Strong]

Or maybe teachers just didn't know what the exhibition was really about, in a similar way to the Ecotarium staff:

> The people in our exhibits department weren't really able to encapsulate what the exhibit was about. That makes it very hard for me to market to an audience that might be attending for five seconds! It doesn't communicate quickly – "Go see an exhibit about circles." So I thought it was going to be a challenge to communicate why people should come: what they'd see, and what they'd actually do and learn. Once I saw the photos and the exhibits themselves, it was much easier to define. It's a fascinating exhibit, I really enjoyed it: colorful, active, but it's something you had to see to understand. [Ecotarium]

> The name doesn't really have anything to sell to funders, and also from the marketing angle it was hard. By comparison, the summer before we had *Memory*, which worked really well from a funding perspective: we hooked up with a pharmaceutical company that worked on Alzheimer's medications. And with *Grossology,* you just have to say the name and people already have a reaction to it, plus there are books and so on, so there's a lot behind it. *Secrets of Circles* is a little long and abstract. It's such a great exhibit, but you don't get that from the name. I don't think it gets across the excitement that the experience of the exhibit actually is. Even looking at the pictures didn't get that across - without people in it, it's hard to tell how much fun it is… [Ecotarium]

e) <u>How easily could staff create related programs to support the exhibition at their sites?</u>

Staff at both host sites were able to create public programs on the Circles theme that were appropriate to their particular institutions. While both sites did use the materials that came with the exhibition, they modified some of them to fit their needs, and created other creative programs from scratch. In particular, Strong staff were excited by the different directions the topic took them.

> …when it opened, we themed some of our animal encounters on circles, like asking what animals sleep in a circle. [Ecotarium]

> Our Public Programs staff created the opening weekend event to get the public's attention and bring guests in. Another week we had the circles theme running through our public programs. Then we also did something unusual: "Circles Saturdays" for a few hours on a Saturday, where a ring-master came and did a variety of activities. All of those didn't happen within the exhibit, but in other places, and they complemented the exhibit. [Strong]

> I don't recall it being particularly different from other exhibits we've had, but I liked the topic. Certainly it was no harder to plan for than other exhibits, and I liked the creative angle on it. From a public programs point of view, it wasn't one of our bigger draws, partly because there's no name recognition that goes with it, as there would be

> if we had something like Clifford the Big Red Dog. …But we were excited by the idea of circles, and all the possible directions we could take it: nature, science, craft, many ways to go. [Strong]
>
> Usually we create our own from scratch. … The family science activities booklet is very attractive and nicely put together, with some ideas we used, somewhat modified…We also hired performers and trained our hosts (who are part-time workers interacting with guests)...We didn't put anything on a table that was running all the time; it was limited to a certain time period, and it was guided. [Strong]
>
> We pulled from the circles theme and brain-stormed anything we could think of. We looked at the theme through the various lenses of arts, math, nature, and so on, and we figured out what we could do within our budget. So it was inspiring and fun, and also challenging. It got us thinking in a new direction, and also gave us an excuse to pull in artists: We had a Tibetan monk come in and make a mandala, and we had an artist who knew all about the math, who showed the kids how to make 3-d paper spheres of different levels of complexity. And we got in a bubble performer, so that was another nice connection. It was kind of fun, looking through the lens of circles. [Strong]

f) Were the supporting materials and activity guides helpful to the staff at the remote sites?

The *Secrets of Circles* exhibition came with a collection of educational programming resources. At each remote site, only a subset of the materials were used by staff, often because they did not fit with the existing structure of programs, or because the organizations already had "enough on their plates" with their existing commitments, or the materials arrived too late to be useful.

Staff sometimes commented on particular resources that came with the exhibition (such as the exhibit descriptions, program descriptions, and activity materials), and these specific comments are listed in Appendix M.

In addition, the exhibition came with marketing materials. Many of these, such as the website and pre-translated press releases, were found useful by the hosting organizations. However, some materials were not recalled by staff, and others proved to be problematic. The most frustrating components seemed to be the advertising material, which several staff members found unclear or constraining in their rules and lack of usable images. Detailed responses to specific marketing materials can also be found in Appendix M.

Finally, it is worth mentioning that *Secrets of Circles* inspired Ecotarium staff to start a new marketing technique: creating videos of people using exhibits as a tool to show potential buyers and/or funders of exhibits.

> …So now we're starting something new: we're taking videos of the exhibits we market, videos that show people using them, and we'll use the videos to sell the exhibits and explain them to funders. And I'm hoping I can also use excerpts of them

> for marketing, or to put on our website, but it's all about the interactions, because just looking at a photo of the exhibit you can see that it's thoughtfully constructed, but not how fun it is. [Ecotarium]

g) <u>How were the multicultural components of the exhibition received, particularly at sites that did not have a significant Vietnamese community?</u>

Staff from both institutions were supportive of the multilingual labels, even in cases where the specific languages were not common at their sites. Sometimes they felt the need to explain the exhibition's language choices to their visitors:

> We have a fairly large crowd of Spanish speakers, and I'd notice them using that text… We don't have so many Vietnamese speakers. I don't know of any specific comments people made about the labels, either positive or negative. But there were generally positive responses to the idea of reaching out to other communities, giving everyone a place to go… Occasionally people would ask why they were in three languages, when the rest of our stuff isn't. I think they were especially confused about the Vietnamese. I explained that the people who designed the exhibit felt that there were two particular audiences they needed to reach out to in their area. [Ecotarium]

> Our main audience languages would probably be English and Spanish. We're pretty close to Canada but we don't get a lot of Canadian tourists. Maybe French would come in third, but I'm not sure….[The trilingual signage and materials] didn't influence our decision to rent the exhibition, but we certainly thought it provided nice added value. [Strong]

> The trilingual labels were handled well; you have to have lots of additional text, but it didn't feel like it was wordy. And I like the fact that we appeal to diverse audiences; it sends a nice message. Guests made better use of them than long labels that explain why something is here. I didn't actually notice anyone using the different language labels, though. [Strong]

The Vietnamese and Asian themes of the exhibition design were not seen by the staff as having a significant impact on the visitor experience. However, effective design is often transparent to users, so this does not imply that the design was ineffective.

> I heard no comments on the cultural aspect. I think a lot of people picked it up and just took it in their stride. [Strong]

> I don't think anybody noticed an Asian theme in the design. [Ecotarium]

> …The cultural aspect is something people appreciated but maybe didn't talk about. [Ecotarium]

h) Did the exhibition inspire any kind of multicultural outreach on the part of the host organizations?

In an impressive example, the staff at the Ecotarium used the *Secrets of Circles* exhibition to move forward on their program of outreach to the local Hispanic community:

> We've been talking about and trying to reach out to the Latino and Asian communities, but really without success. And this gave us a great reason to pursue that. The Latino community really stepped up to help, and we were very successful, in terms of both having an event and getting funding for it. We invited 500 people with free admission, for a "Fiesta under the Moon."…The event mushroomed into something more elaborate than we'd originally planned, but the expansion came with energy and people, and the basic goal of reaching out to those communities panned out well. A local bank even gave us a gift and said they'd match it with other local banks, which is very unusual… So overall we had 15 local agencies work with us and help organize and fund-raise, and they got to see the exhibits and a planetarium show, and now they're talking about doing something with us again next year. [Ecotarium]

> There's a good size Hispanic community in Worcester, and also an Asian community. We did a Hispanic event for *Secrets of Circles,* that was inspired by the fact that the exhibition was multilingual. We met with leaders and people who run different programs in the local Hispanic community, and we had several meetings with them...Originally we were going to have something just for them, and then they could pass the word on to their communities that *Secrets of Circles* was multilingual, but it grew quickly and we ended up having the families they serve come to Ecotarium for an evening event… We gave out tickets that had free entry for 5 people on each, and we tried to organize it so they were given to families that would really want to see the exhibition. In the end we gave out 100 tickets, for 500 people, and on the night we had 285. We're not typically open in the evening, so we needed volunteers. And we got help from youth groups, and people in the community volunteered, and we had to buddy them up with regular Ecotarium volunteers and staff, because we have 20 acres of outdoor trails in addition to the museum. We had some of the volunteers who were Spanish-speaking to staff the desk and the gate, so they could welcome people. And some people organized transport, and we ran our train, and other people organized car pools... We did free train rides all night, and had free planetarium showings. Food worked out because we had generous donations. Logistically it was tricky but we worked all that out. And it was especially nice because many of the people who came couldn't afford to come normally, and we could tell the organization heads about the reduced rates we have for groups, even small groups. [Ecotarium]

> It was hugely popular: lots of people, and people who may not have come otherwise, because they might think they won't get anything out of it, especially if they don't speak English well. It really made them feel welcome. [Ecotarium]

> We hadn't ever done this before. In our own work, we've been trying to develop more multilingual exhibits going forward. With the *Circles* exhibition, it gave us the chance

> to really try to push it. We'll probably do something similar in the future, but a bit smaller, with more passes to fewer organizations, passes and group rate. [Ecotarium]

The staff had planned a similar event for the Vietnamese community, though they weren't able to bring this to fruition:

> We were going to do an event for the Asian community too, but after the size of this, we knew we couldn't do the same thing. We looked to have the leaders come in, thinking we might go back to the model where they came in and then spread the word in their organizations, but we sort of ran out of time, with so much else going on during that month. So we didn't do it in the end. [Ecotarium]

> The Latino community is very well connected: active, with lots of agencies and established family networks, city networks, professional networks, so you can reach leaders and professionals in those communities. And the museum had connections with those people already – not strong, but something, and this helped us to strengthen those connections. We did try to reach out to Vietnamese community leaders and we sent the press releases, which was all we had in Vietnamese. We sent it out to specific people, and there was some discussion of an event, and we tried to get one going but it didn't actually happen. [Ecotarium]

These two examples highlight both the obstacles and rewards the Ecotarium staff came across in their efforts to expand community participation. The *Secrets of Circles* exhibition was a catalyst for them, and they seem to be on a trajectory of continued connection with Hispanic community groups in the future.

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Recommendations

Overall, the Secrets of Circles exhibition and related materials showed success in many dimensions, including: long holding times, high percentage of diligent visitors, involvement by adults as well as children, high salience of the Circles theme, extended engagement of girls in a STEM-related exhibition, pleasing design, relevance to visitors' daily lives, well-received and thematically-effective multilingual labels. The associated Family Science Night programming was welcomed and effectively used at least in one case, and staff at the first two sites to host the traveling exhibition were pleased with its performance and used the multicultural focus to extend their own connections with their local communities. These successes were probably due to a combination of institutional commitment to in-depth prototyping, close collaboration with UCSC psychologies, a well-equipped in-house production facility, and a core of experienced and innovative staff in exhibits and programs.

That said, we list here some recommendations that may be helpful for CDM's future exhibition development projects, as well as for the ongoing support of the traveling exhibition.

Specific suggestions for the exhibition

• Consider a safer design for Giant Tire.
Giant Tire had to be removed or bolted down at both Strong and the Ecotarium because of injuries, apparently pinching of arms or fingers. This is a pity, because it was very popular in protoype form, and provided a whole-body immersion experience of spinning. Also, it often brought adults (particularly men) into active involvement with their children to assist with the spinning. Perhaps CDM staff, who ingeniously designed a safer rotation mechanism for On a Roll, could rethink a design for Giant Tire that would be less dangerous but still interactive.

• Monitor Build an Arch and Round Boat for safety.
Both Build an Arch and the Round Boat generated some safety concerns at the hosting museums. These were not shut down due to actual injury (in fact, Build an Arch is a common exhibit at other museums), but are worth monitoring for future incidents.

• Monitor Ripple Table for functionality.
During the summative evaluation and even afterwards, Ripple Table was not observed functioning fully; there seem to be frequent problems with the functioning of one or more wands, and sometimes the response to tapping was slow or unpredictable. While staff interviews suggest that this has been resolved in the traveling version, they also point to the delicacy of alignment of the components in this piece.

• Consider adding secondary labels to a few exhibits.
Overall the exhibits seemed to work very well. However, CDM might want to undertake a few more focused observations of exhibits that reportedly caused occasional visitor confusions, and consider adding a secondary label where appropriate. For example, Build an

Arch might include a diagram to show that the form should be removed before being walked on. On a Roll might benefit from a label showing the spinning of a disk, for times when no staff member is available to demonstrate this behavior. Lathe might benefit from a more explicit label that suggests a rocking motion with the feet. And Spin Pictures might benefit from an arrow or other label to encourage visitors to spin the inner turntable off-axis from the outer one. These problems seemed minor, and may not be worth addressing if they represent rare frustrations (their quantification was beyond the scope of this study).

Similarly, a small number of adults requested more from the labels, not only in terms of instructions but also explanations. Perhaps a secondary label could be added to a few exhibits where adults seemed eager to look for a bit more explanatory information to guide the children. For example, Build an Arch might benefit from a bit more about why a circular shape helps it be strong, or Bumpy Road might explain that the circular shape is smoothest because a circle has a constant radius. The wheels in Inventing the Wheel could be painted a bright color to help adults guide their children to see the key difference between the two situations, and there might be some kind of statement about energy lost to sliding friction. Given that older children and even adults were quite engaged with the exhibition, a scattering of deeper explanations might help families who want to go further, make a stronger connection between the shape of a circle and its functionality, or bring in a bit more vocabulary.

<u>Suggestions about dissemination via the traveling the exhibition</u>

• Revise the marketing materials to make it clear that this exhibition is not just for small children.
Ecotarium staff were concerned that the exhibition was aimed at too young an audience, and were surprised by its actual ability to engage older and broader audiences. In fact, of the handful of the age-related criticisms from adults at CDM, most were that there wasn't *enough* for young children. The color brochure shows mostly photographs of young children, and the language also sounds very youthful; perhaps these could be revised to reflect a broader range of ages. This may also be a factor in the reluctance of schools to sign up for some Circles-related programs (experienced at Strong).

• Revise the marketing materials to better reflect the high energy of the exhibition.
Staff at the hosting sites reported being surprised that the exhibition was so interactive and lively; some said it was "more fun than it looked from the static photographs." Perhaps CDM could consider including short videos in its materials, or photos that show larger groups of people engaged together at a lively exhibit such as On a Roll.

• Consider focusing the marketing materials on a narrower message.
The current marketing brochure emphasizes all the places circles can be found, but there is much less emphasis on the principles behind the use of circles and wheels: aspects of symmetry, strength, interlocking of gears, smoothness when spinning, construction possibilities, etc. Yet these ideas are powerfully embodied in many of the interactive exhibits, and give the exhibition its strongest connection to STEM content. Staff at the Ecotarium

talked about their difficulties figuring out what the exhibit was about and communicating it in a compelling way to funders. Perhaps the current emphasis on "circles are everywhere," though accurate and accessible, is too broad a characterization of what the exhibit offers, and it may reinforce the idea that the exhibition is only suitable for a very young audience. CDM might try emphasizing the mathematics and physics inherent in many of the elements to capture the interest of older and school-based audiences (e.g. "Unlock the mysteries and power of the circular shape"), or the exciting opportunities to build and create wheel-based systems (e.g., "Explore the whirling world of circles, and create curvy structures of your own.")

• Warn other hosting museums to expect high ongoing maintenance.
The exhibition is highly interactive, and appeals to a broad range of visitor ages, including older children. For these reasons, it is likely to have ongoing maintenance needs that some museums may not anticipate.

• Let hosting museums know that the crates require storage.
While both museums interviewed appreciated the thoughtful custom-designed crates, they pointed out that the extra storage required, especially given that the crates do not stack within each other, could be a major obstacle to other institutions hoping to rent the exhibition.

• Be clearer with venues early on about the advertising constraints, and provide more templates in multiple media with variations if possible.
There was some frustration on the part of Strong staff that they did not receive templates or a range of usable component images to make up advertisements for the exhibition. Also, a lively radio script, and a set of broadcast-approved video clips, would further help institutions that invest in broadcast or web-based advertising. Finally, the constraints related to advertisements (such as presence and size of NSF and CDM acknowledgements) should be shared as early as possible with hosting institutions to avoid misunderstandings or last-minute stress.

<u>Furthering connections with local Mexican- and Vietnamese descent families</u>

• Continue to integrate cultural design elements with STEM topics.
Families of Mexican- or Vietnamese descent who participated in this evaluation mostly had similar experiences to those of the regular audience, and valued the exhibition in similar ways. The combination of cultural design and STEM content did not seem troubling to any of the audiences studied, so we encourage CDM to continue this strand of their work.

• Continue with multilingual labels.
Support for multilingual labels was very strong, not just among speakers of Spanish or Vietnamese (who were extremely supportive), but across the spectrum of languages and cultures of CDM visitors. Keeping the labels brief, accessible, and consistently colored (as in *Secrets of Circles)* seems key to managing the potential for visitor overwhelm. In fact, data suggest that CDM could even slightly increase the amount of label text, perhaps by adding secondary or less prominent explanations for some of the exhibits where parents requested

more information. Staff might also consider adding laminated sheets at the entry to the exhibition for some of the other languages commonly spoken by their diverse audience.

• Avoid mixing iconic objects from different cultures in a single element.
The strong responses of first-generation Vietnamese adults to the Chinese hats used in the Vietnamese round boat suggests that it may be particularly important to keep specific cultural icons clear and distinct. These adults seemed most concerned that other visitors would misunderstand aspects of the Vietnamese culture that was supposedly being represented. Even though the use of the Chinese hats was considered by CDM staff to be a minor change, based on the fragility of Vietnamese hats originally put in the exhibit, some of the targeted audience would rather have "no hats" than Chinese hats.

• Continue reaching out to these communities.
Despite CDM's many attempts (current and previous) to reach out to both Latino and Vietnamese communities, these groups were still quite under-represented in the regular weekend audience, compared with the population of San Jose. Some of the Vietnamese families identified likely obstacles to greater community visitation, but most seemed not to even know about CDM's existence or previous exhibits and programs for their community. Given that the museum has multicultural and multilingual exhibits and programs as permanent offerings, perhaps more energy could be focused on increasing awareness of these through local media and via involvement of the advisory groups already in place. The existing connections to the ICAN group seem particularly promising in terms of helping parents to reconsider their definitions of learning by their children; such programmatic introductions might help parents of all cultural backgrounds to appreciate more fully the value of CDM as an informal learning setting.

In summary, the limited data from this study suggest at least four framings for further community involvement:

(i) Getting the word out to people who do not yet know of CDM's existence;
(ii) Minimizing or solving the logistical and economic barriers for those who want to visit;
(iii) Increasing the number and profile of culturally specific offerings (such as the *Dragons and Fairies* exhibition, Lunada Familiar, or Three Kings Celebration) to the point where CDM becomes a cultural destination for parents to bring their children (according to Quyen Dinh, *Secrets of Circles* would probably not be enough to achieve this);
(iv) Creating or connecting with existing programs to help families see the museum as a useful learning resource rather than merely an alternative to "a movie ticket." This would not require the museum to generate more culturally-specific offerings.

Of course, this kind of community outreach and collaboration is difficult and takes years to accomplish, as was articulated by the community leader Quyen Dinh when she expressed her deep appreciation and support for what CDM is attempting.

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Adam Klinger helped to design the tracking and timing study, collected the observational data, conducted many of the statistical analyses, and contributed to the report write-up. Joyce Ma custom-designed the software used to collect and display the tracking and timing data, and generated the Movement Maps for different subgroups of visitors. Claudio Gonzalez, Rocio Navarro, and Let Vu helped design and test the interview instruments and conducted all the visitor interviews. Mary Kidwell helped design and pilot-test many of the instruments used in the final studies. Cecilia Garibay, Veronica Garcia-Luis, and Lorrie Beaumont contributed methodological suggestions and generously shared their time and insights. UC Santa Cruz faculty members Maureen Callanan and Lara Triona shared their research frameworks and some findings from their formative studies, and helped identify specific summative studies that would complement their own research with the CDM staff.

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Staff at the Ecotarium, Strong National Museum of Play, and International Children Assistance Network agreed to be interviewed, and gave thoughtful and detailed responses to the exhibition and related materials. They included: Sarah Boutric, Tracy Dill, Quyen Dihn, Sally Anne Giedrys, Jennifer Glick, Lindsey Gouvin, Matt Handy, Corrie Kraai, Betsy Loring, Stephen Pitcher, and Susan Trien.

Finally, this report reflects the honest, thoughtful, and detailed responses of hundreds of families at the Children's Discovery Museum and also Dilworth Elementary School, who were willing to be interviewed about their experience.

This study, as well as the *Secrets of Circles* project, was supported by the National Science Foundation.

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Appendix A: List of exhibition elements
(excluding benches, with descriptions from *Secrets of Circles* brochure)

Book Bench

Parents and children enjoy cozying up together to read books from many cultures about circles, wheels, and the whole whirling world.

Build an Arch

Buildings around the world employ the strength of curves and the efficiency of circles. Visitors explore round structures and build a round arch bridge they can walk over.

Bumpy Ride

What if wheels weren't round? What if they didn't have the axle at the center? Visitors play with unusual cars and the rides they take.

Circle Videos

With the spin of a dial, visitors explore videos of circles whirling, waving, and working in the world.

Circles Diorama

Visitors look for circular shapes in this circle-full diorama. There are cones, cylinders, spheres, and even a torus or two.

Circles in the World

Visitors pretend and play in a market full of circles from around the globe. Onions, pulleys, baskets, a Vietnamese round boat, and more.

Methodological note: For the tracking and timing study, we considered this as two exhibits, based on the two main locations where visitors stopped:

(a) Round Boat: (on right)
Visitors can sit in a Vietnamese round boat with oars.
(b) Everything else - "Non-boat" (on left)
Visitors can dress up in fabrics and hats, use a pulley and bucket containing plastic fruit, or push wooden blocks through holes based on the circularity of their shapes.

Compass Table

Visitors draw circle after perfect circle on a glow-in-the-dark table using three different kinds of compasses.

Family of Circles

Glowing circles slide, whirl, and spin, changing into a cylinder, a sphere, and a torus.

Gears

People reinvented the wheel by adding teeth to make gears. Visitors build their own gear contraptions to turn a music box, a clock, and a drill.

Giant Tire

Children and adults alike love stepping inside this giant truck's tire and moving it from the inside.

Inventing the Wheel

Visitors compare the difficulty of lugging one brick on a flat platform and one on wheels as they get first-hand experience with the importance of the invention of the wheel.

Kaleidoscope

Visitors use mirrors to experiment with circular symmetry. One slice of pizza becomes a whole pie, one peacock feather becomes a whole fan.

Lathe

Visitors use a modern version of an ancient lathe, slowly and safely carving the wood into fanciful circular shapes

Lathe Slices

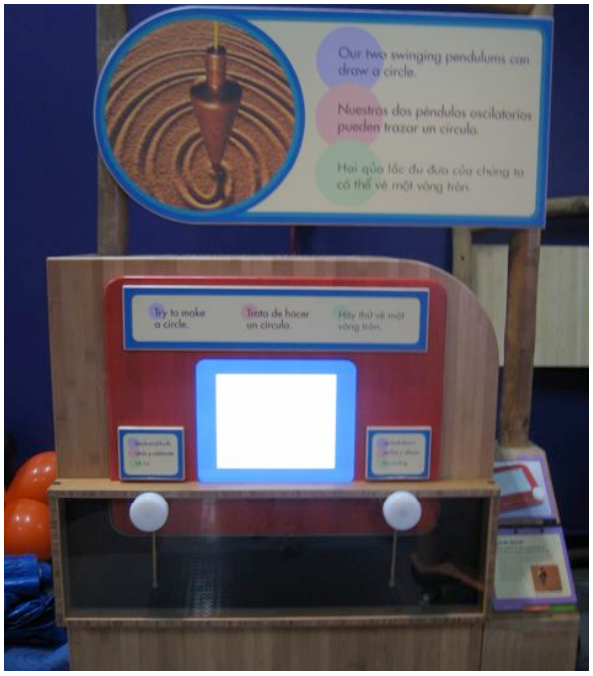
(associated exhibit allows visitors to stack circular shapes on a central axle to make shapes similar to those carved at the nearby lathe).

On a Roll

As balls and discs careen across a slowly moving turntable, children explore the spinning and rolling patterns of different three-dimensional circles.

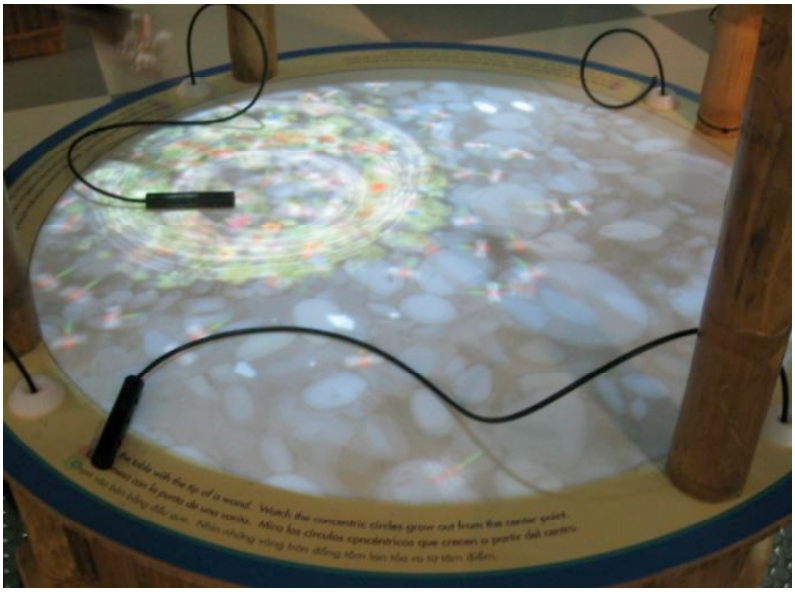
Pendulum Dance

It's hard to draw a circle with an Etch A Sketch®. Our computerized version has pendulums attached to the knobs, making it easy for visitors to discover that back-and-forth plus up-and-down sometimes equals round-and-round.



Ripple Table

With the touch of a wand to our digital pond, circles ripple outward, dragonflies swirl, and round flowers grow in rings.



Round and Round

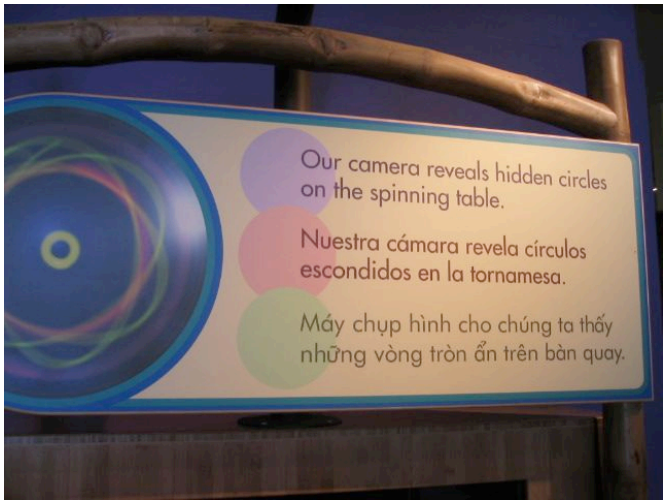
Three sticks, each a different length, radiate out from a center point. Visitors start them spinning, and what do they see? Three circles, in three different sizes.

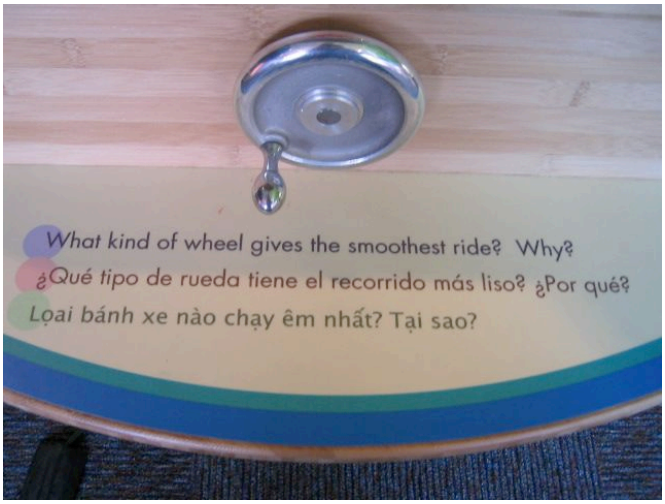
Spin Pictures

Visitors place lights on turntables and set them spinning. A camera catches the motion and displays the striking circular images for all to see.

Examples of large-format signs / banners

Appendix B: Examples of exhibition labels

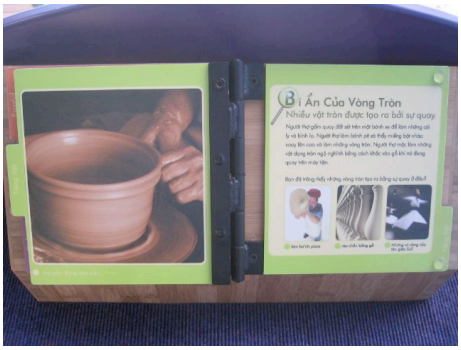




Example of “in-depth graphic” from Lathe Slices exhibit

Page 1

Page 2



Page 3

Appendix C: Exhibit list with visitor behaviors each could support

	Sat	Called over	Pointed	Took photo	Physically used exhibit	Read in-depth graphic aloud	Read in-depth graphic silently	Read label aloud	Was accompanied	Talked with adult	Talked with child	Used along-side adult	Used along-side child
Book Bench	1	1	1	1	Opened book			1	1	1	1	1	1
Build an Arch	1	1	1	1	Touched / walked on bridge			1	1	1	1	1	1
Bumpy Ride	1	1	1	1	Turned wheel	1	1	1	1	1	1	1	1
Circle Videos	1	1	1	1	Turned dial			1	1	1	1	1	1
Circles Diorama	1	1	1	1				1	1	1	1		
Circles in the World: boat	1	1	1	1	Got in boat / touched paddle / looked inside	1	1	1	1	1	1	1	1
Circles in the World: non-boat	1	1	1	1	Role-played / played with objects / pulled pulleys	1	1	1	1	1	1	1	1
Compass Table	1	1	1	1	Touched compass or turntable	1	1	1	1	1	1	1	1
Family of Circles	1	1	1	1	Turned wheel	1	1	1	1	1	1	1	1
Gears	1	1	1	1	Touched gears	1	1	1	1	1	1	1	1
Giant Tire	1	1	1	1	Got in / turned tire			1	1	1	1	1	1
Inventing the Wheel	1	1	1	1	Pulled rope	1	1	1	1	1	1	1	1
Kaleidoscope	1	1	1	1	Touched mirrors or objects	1	1	1	1	1	1	1	1
Lathe	1	1	1	1	Pushed pedal / touched lathe or tool			1	1	1	1	1	1
Lathe Slices	1	1	1	1	Touched shapes	1	1	1	1	1	1	1	1
On a Roll	1	1	1	1	Touched objects or turntable			1	1	1	1	1	1
Pendulum Dance	1	1	1	1	Touched dial or pendulum	1	1	1	1	1	1	1	1
Ripple Table	1	1	1	1	Touched light wand			1	1	1	1	1	1
Round and Round	1	1	1	1	Spun wheel			1	1	1	1	1	1
Spin Pictures	1	1	1	1	Touched table / objects / button	1	1	1	1	1	1	1	1

	Sat	Called over	Pointed	Took photo	Physically used exhibit	Read in-depth graphic aloud	Read in-depth graphic silently	Read label aloud	Was accompanied	Talked with adult	Talked with child	Used along-side adult	Used along-side child
Intro sign with hole	1	1	1	1	Went through hole			1	1	1	1	1	1
S1	1	1	1	1				1	1	1	1		
S2	1	1	1	1				1	1	1	1		
S3	1	1	1	1				1	1	1	1		
S4	1	1	1	1				1	1	1	1		
Bench B1	1	1	1	1					1	1	1		
B2	1	1	1	1					1	1	1		
B3	1	1	1	1					1	1	1		
B4	1	1	1	1					1	1	1		
B5	1	1	1	1					1	1	1		

Appendix D: Adults' interview questions (reformatted to save space)

Date: *Time:* *Interviewer:*

What was something in there that you particularly liked or enjoyed? (what about it did you particularly enjoy?)
¿Que fue algo que le gusto o que disfruto en particular?

Did you notice any common idea or theme in the room?
¿Ud notó alguna idea o tema en común en el cuarto?

(If they say "Circles," ask "Could you say a bit more, like what about circles?")
¿Nos podria decir poquito mas sobre esto?

Was there anything you were reminded of, any connections between things in this room and something from your own life?
¿Hubo algo que le hizo recordar, o hacer conexiones entre las cosas en este cuarto y las cosas en su propia vida?

While you were in the room, did you notice anything that had a circle shape that made it work well, or helped it to do what it needed to do?
¿Mientras estaba en el cuarto, noto algo que tenia forma circular donde la parte circular lo hacia que trabajara?

How did the circle shape help it?
¿De que manera le ayuda tener forma circular?

While you were exploring and doing things, was there anything you realized or were reminded about circles?
Mientras estaba explorando y haciendo las actividades, hubo algo que noto o que le recordo a circulos?

Did you notice anything about the design of this room - like the colors, materials, or the look of the furniture and the signs?
¿Noto algo hacerca del diseño de este cuarto - como los colores, materiales o el parecer de los muebles y los letreros?

(If haven't already said): What did you like or dislike about that?
¿Que le gusto o no le gusto de eso?

Did you notice that the labels in the room were in different languages? Y N
¿Se dio cuenta de que los letreros de esta exhibición estan en varios idiomas? Sí No

What was your general response to them?
¿Cuál fue su reacción general a estos letreros?

Did you read them, or use them in any way?
¿Los leyó? O ¿los uso en alguna manera?

If you were making a recommendation to the museum about whether they should have labels only in English or in other languages as well, what would you recommend:
*Si usted estubiera haciendo una recomendación al museo hacerca de los letreros,l*es *recomendaria que fueran en ingles solament*e o en otros idiomas tambien?

English only	English and other languages	No preference
Ingles solamente	*Inglés y otros idiomas*	*No preferencia*

(Record any comment they add here):
(Agregue cualquier comentario aquí):

What language do you mostly speak at home? _____
¿Por lo regular, que idioma habla en su casa? _____

How would you describe your ethnic origin or nationality? (This helps the museum know how well we serve different communities)
¿Como describiría su origen étnico o su nacionalidad? (esta información le ayuda al museum a saber en qué medida sirve a las diversas comunidades de esta área).

And can I ask you your zip code?
¿Puedo preguntarle su codigo postal?
Is this your first visit to the Children's Discovery Museum? Y N

¿Es esta su primera visita al Children's Discovery Museum? Sí No
[Museo de descubrimiento para los niños]

Are you a member? Y N
¿Es Usted un miembro/a? Sí No

Have you visited the "Secrets of Circles" room before (earlier today or on other days)?
¿Usted ha visitado el cuarto de "Secrets of Circles" (secretos de los Circulos) antes (hoy o en otros dias) ? Y N *Sí No*

How many people are visiting in your group today? _____
¿Con cuantas personas viene hoy? _____

Please help us out by telling us a little about yourself:

1) Your gender: F M
Su Género: Mujer Hombre

2) Your age: (show them this table):
Su edad:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

3) How old are the people in your group?
¿Cuantos años tienen los niños y niñas en su grupo?

Gender: _____ Age: _____
Género: *Edad*:
Gender: _____ Age: _____

Gender: _____ Age: _____

Gender: _____ Age: _____

Gender: _____ Age: _____

Is there anything else you'd like us to know about your experience in the Circles room?
¿Hay algo mas que le gustaria decirnos acerca de su experiencia en el cuarto de círculos?

Thank you so much for helping the museum today!
Muchisimas gracias por ayudar al museo hoy!

Appendix E: Children's interview questions (reformatted to save space)

Date: Time: Interviewer:

Child's gender: Child's age:

Interview with Child

Hello again, my name is xxx. What's your name? Here's some pictures of all the things in the Circle Room. Take a look at them – do you see the ones you played with? [Let them process this for a few seconds, and wait if they point out some to you.]
Hola de nuevo, mi nombre es xxx, ¿Como te llamas? Aqui hay unas fotos del cuarto de circulos. Miralos, ¿ves las cosas con las que jugaste? [Let them process this for a few seconds, and wait if they point out some to you.]

Which of these things was your favorite?
¿Cual de estas cosas fue tu favorito?

> Can you tell me what made it your favorite?
> ¿Me puedes decir que es lo que lo hizo tu favorito?
>
> Tell me more about that one, was there anything else you did with that one?
> *Dime un poquito mas hacerca de esa cosa, hubo otra cosa que hiciste?*
>
> Can you finish this sentence:
> When I was playing with that one, it made me think about…
> Cuando estaba jugando con ese, me hizo pensar en…
>
> Can you tell me a bit more about that? What did you figure out about xxx?
> *Dime un poquito mas hacerca de esa cosa, Que descubriste de xxx?*

Do you think there were any circles in that exhibit? (that one, just your favorite one)
¿Habían algunos círculos en esa exhibición?

> Where? (let them show you or tell you)
> ¿Donde?
>
> Does it have to be a circle, or could it be a different shape (why?)
> Tiene que ser un circulo, o puede tener otra forma?

When you were in the Circles room, did you ever think "this reminds me of another place I sometimes go, or a place I imagine going to.'"
Cuando estabas en el cuarto de circulos, pensaste "esto me recuerda a otro lugar que a veces voy, o a un lugar donde imagino ir."

When you played with all these different things in the room, did any of these things (point to sheet) remind you of something in your life?
Cuando jugaste con las diferentes cosas en el cuarto, algunas de estas cosas te recordaron a algo en tu vida?

Now I'm going to start a sentence and you can finish it however you want, ok?
Ahora vamos a jugar un juego, donde yo voy a decir algo y tu vas a terminar lo que estoy diciendo como tu quieras, ok?

Being in the Circles room was fun because….
Estar en el cuarto de circulos fue divertiodo porque …..

A circle I see every day is…
Un círculo que veo cada dia es…..

Most people don't even know that there's a circle….
La mayoría de la gente no sabe que hay un círculo…

The best thing about a circle is….
La mejor cosa de un círculo es …

(Thank them and give every child in family thank you gift).

Appendix F: Photo-sheet shown during interviews, to remind children of all interactive exhibits in the exhibition
(photo-sheet changed daily to reflect exhibits temporarily off the floor)

Appendix G: Questionnaire for adult caregiver of interviewed child (English version)

Please tell us a little about yourself

Is this your first visit to the Children's Discovery Museum? Y N

Are you a member? Y N

Have you visited the "Secrets of Circles" room before (earlier today, or on other days)?
Y N

What language do you mostly speak at home? _____

How would you describe your ethnic origin or nationality? (This helps the museum know how well we serve different communities) _____

_____

How many people are visiting in your group today? _____

What is your zip code? _____

Your gender: M F

Your age : 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

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Others in your group:

1. Gender: M F

Age: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

2. Gender: M F

Age: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

3. Gender: M F

Age: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

4. Gender: M F

Age: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

5. Gender: M F

Age: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

6. Gender: M F

Age: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

7. Gender: M F

Age: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

Thank you so much for helping the museum today!

Appendix H: Questionnaire for adult caregiver of interviewed child (Spanish version)

Por favor díganos más acerca de usted

¿Es esta su primera visita al Children's Discovery Museum? Sí No
[Museo de descubrimiento para los niños]

¿Es Usted un miembro/a? Sí No

¿Usted ha visitado el cuarto de "Secrets of Circles" (Secretos de los Circulos) antes (hoy o en otra ocasión)? Sí No

¿Por lo regular, que idioma hablan en casa?_____

¿Como describiría su origen étnico o su nacionalidad? (esta información le ayuda al museum a saber en qué medida sirve a las diversas comunidades de esta área).
_____

¿Con cuantas personas viene hoy?

¿Cuál es su codigo postal?_____

Su Género: Mujer Hombre

Su edad: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

Personas en su grupo:

1. Género: Mujer Hombre

Edad: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
18-25 26-35 36-45 46-55 56-65 66-75 76-95

2. Género: Mujer Hombre

Edad: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

3. Género: Mujer Hombre

Edad: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

4. Género: Mujer Hombre

Edad: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

5. Género: Mujer Hombre

Edad: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

6. Género: Mujer Hombre

Edad: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

7. Género: Mujer Hombre

Edad: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

18-25 26-35 36-45 46-55 56-65 66-75 76-95

Muchas gracias por ayudar al museo hoy!

Appendix I: Interview questions for staff at remote sites who rented traveling exhibition

Hi, and thanks for being willing to talk to me. (do a time check: try to have 45-60 mins if possible).

My name is Sue Allen and I'm doing the summative evaluation for the Secrets of Circles project, which is required by all NSF-funded projects. So my job is to find out about the exhibition and how it's working at the different places it's touring, so I can report back to the funder (NSF) and also to the folks at San Jose Children's Discovery Museum.

Do you have any questions for me before we start?

Can you tell me your official title at the museum?

And how were you involved with the Secrets of Circles exhibition? (during setup, day to day, programs, etc.)

How did the installation go? Were there any issues or decisions you had to make?

And can you tell me a bit about how the exhibition was set up at your place: did you have it in a separate gallery, or integrated with other parts of your floor? Were there issues there?

How bright was the lighting?

Was it flexible enough for you, with the moving pieces on castors? Were the pieces easy to integrate together into a collection?

So I'm interested to hear some things about the exhibition, and I just want to start by saying it really helps if you're honest about the negative things as well as the positive, because the folks at San Jose CDM really want to know how they could improve their traveling exhibits, as well as just hearing the good stuff. Is that ok with you?

So how long ago did you have the exhibition at your institution?

And what was your response to it, overall?

By any chance, have you done any kinds of interviews with visitors, or tracked how long they stay in the exhibition?

How did it compare with other traveling exhibitions you've had before? Did it present an opportunity to try anything different?

What was your sense of the age range it was designed for, based on seeing the real thing and watching people use it?

Did it appeal to a different age group from most of your exhibits, or is that the same age group you usually target? How has it worked with your teen audience, and your field trip audiences?

Do have any ways of hearing back from your audiences – like comment cards, or exit interviews with visitors, or anything like that? If so, did you get anything related to the Secrets of Circles exhibition in particular? (If not yet, can I call back about that at a better time?)

Let's talk about the three languages: the exhibition labels are in English, Spanish and Vietnamese. How did you find your audiences responding to those? Did you see people using them or talking about them?

Which of them are well represented in your audience?

Did you have any stories about how well they worked, either from staff or visitors? Was anyone confused or puzzled about the labels?

Any negative responses from staff or visitors overall?

Did anyone seem confused by anything in the exhibition?

Was the exhibition different at all from your expectations?

How has it been for your institution, having an exhibition with a math focus but also a cultural element? Do you know if visitors realize it's about a particular topic? Do they value that?

Any thoughts on whether families are learning any math or science content? Do they realize they might be learning something? What do the parents say about their children's learning?

Did you get any responses from staff or visitors about the exhibit design – the look and feel?

How about the mechanical aspects of the exhibition – have you run into problems, either things that visitors struggle with, or things that cause problems for your staff?

There's a few elements in particular I wanted to ask about:

• One exhibit has several tiny LED lights that spin around to make the perception of circles. I know CDM put a new mechanism in that one – have there been any issues?

• There's a bench and a rack with lots of children's books about circles – do you have any idea about how much that was used in your space? (If so, did you notice which books people were using, and how?) At CDM people didn't seem to be using it very much.

• The exhibit where you spin a big turntable with colored objects on it, and take a photo of the patterns it makes – any comments about that one? CDM is doing some in-depth study of it.

Now let's talk about the education and programming resources: Did you use any of these things? (go through). And how did that work for you?

How did you market the exhibition to your audiences?

Was there anything you realized was a good way to attract visitors to the exhibition?

Did you use any of the marketing materials provided? If so, how did they work for you?

I'm looking at the survey form you filled out – and I noticed xxx. Could you tell me a bit more about that? (identify any interesting responses ahead of time.)

Do you have any suggestions for improvements that I could share with the folks at CDM?

Is there anything else you'd like to tell me?

And can I quote you, or would you prefer to be anonymous?

Is there anyone else on your staff you think I should talk to?

Thanks so much for your time. The final report will be online in a few months, at www.informalscience.org.

Appendix J: Protocol and questions from in-depth Vietnamese family interviews

(Email to interviewer describing method):

Hi Le,

Here's my draft of the questions for this weekend.
This one is a different type of interview from the ones we did before. You're not stuck to a fixed list of questions; instead, you'll mostly watch and write down what the families do and say, and have a conversation with them to help you understand what they're doing. The main goal of this is to get to know them as a family, and to understand how they use the exhibits and what they find important about that. So my questions are just a guide – feel free to make up your own.

I've highlighted in bold some of the things I think are especially important to talk about during the interview at the end. The basic plan is to walk with them while they use the exhibits, for about 30 mins, and then interview them for 30 mins. You can interview them all at once if you like, or just an adult if that's easier. And if they're done early or late, just adjust to them.

I'll be around all the time, watching too. But I think it's better if you go with them because they'll probably feel more comfortable with another Vietnamese person than an English person, and it's important for them to relax with you and feel comfortable.

Best,
Sue

In-depth Vietnamese family interview

Welcome, thanks for coming today. My name is Le and I'm going to be hanging out with you today as you look at the Circles exhibit.

What are your names?

And how old are your children?

Have you been to the museum before?

Have you seen this Circles exhibit before?

That's great. The people who work at the museum would like to get some feedback from different Vietnamese families, to find out what they think of this Circles exhibit. They'd like you to go through and use whatever you want to, and then they'd like to know what you like, and what you think could be made better. Just to hear your honest responses, the good things but also the things that don't work so well, so they can learn how to make better exhibits in the future. Does that sound ok?

So we have an hour together, so that's plenty of time to relax and get to know each other a bit. And I thought we could spend about half an hour playing with the exhibits, and then after you've seen everything I'd like to sit down with you after that, for another half an hour, to talk about what you thought of it. Does that sound ok?

So the whole thing will take about an hour, and at the end I have $50 to thank you for your time.

So now you can go ahead and use the exhibits with your family, and I'll come along and chat to you about it, very informally. Is that ok? And I'd like to write down some of the things you tell me, because I have a bad memory so it helps if I can write it down. But anything you tell me will be anonymous, so I'll pass on what you say, but nobody will know who said it.

Getting started:
So this is the Secrets of Circles exhibit, and why don't you do whatever you'd normally do, and I'll just come along with you.

Observing:
[Watch what they do and make notes, especially around the way they use or discuss labels, or any of the Vietnamese aspects of the exhibit design (round boat, clothing, bamboo, etc.).

Look especially for things that seem to help them do things together, or that help them learn. What exhibits and labels help them talk to each other the most? What do they talk about? Follow them and look for the things that seem to really get them interacting and learning together.

When they use the labels, write down what they say and do, and what their goal seems to be. E.g.,

- *Are parents using labels to talk to children in their language, about their culture?*
- *Or to give little ones vocabulary?*
- *Or are they trying to learn the English?*
- *If there are Vietnamese speakers (usually older adults), do they use the labels to communicate with the younger ones (who generally speak more English)?*

You don't have to ask them these questions, you'll get time later. For now, mostly watch what they do and write it down if you can.]

Talking with them while they walk around:
Let them do whatever they do, and watch and listen. Just write down what they say and do that seems interesting. If they do something you find interesting and want to know more about, go ahead and ask them about that (e.g., "can you tell me why you decided to read the English first, and then the Vietnamese?" or "can you tell me what your son is doing there – I don't understand what he's trying to do.") Whenever you ask them something, write down

what you ask as well as what they say. Try to capture as much as you can, but still be talking with them. (I know it's hard to do all at once!)

Interesting topics, if they come up:

- *Vietnamese culture and language*
- *learning of science*
- *whether they see their children as learning anything, or just having fun*
- *any differences between boys and girls*

Also, if you are curious about something, ask them.
Examples:

- I see you were using the round boat. Have you ever seen one before? Did you know it was Vietnamese?
- Do you notice any differences between your boys and girls, in terms of how they're using the exhibits?
- I see you're reading the Vietnamese labels to them. Is that something you often do at home?
- etc. Just chat with them, and take notes on what they say.

Try not to put words in their mouths, mostly be a good listener. A great question to ask is "Can you tell me a bit more about that?"

I would expect that most of the time you'll be writing things down, and occasionally asking questions, so the time may go very quickly and you probably won't get to ask everything.

When they tell you they've done enough
Get to a place where they can sit comfortably, near the exhibit if possible:

What were your impressions, overall? (just let them tell you a bit about what they thought of it.)

What was good about the exhibition, for you?

What was something that wasn't so good?

Did you see anything that reminded you of Vietnamese culture or your own family history? *(if they give you an example, try to get them to say more about it: ask them what they thought about it, what it reminded them of, whether it was different from the real thing in Vietnam, if it brought up any thoughts or feelings for them, etc).*

Anything else that reminded you of Vietnamese culture?
(If they don't mention these):
How about the round-boat?
How about the bamboo in the design of the room?

Let's talk about the labels a bit. I noticed you seemed to read some of them… (or say whatever you noticed while you were watching them). What did you think of the labels being in 3 languages like that?
Did it help you talk with your children at all?
How does it help them? (might be to learn the science, or the language, or the culture…)

Does seeing the Vietnamese language make you feel more at home in this area, or doesn't it really make much difference to you?
If it had just been English, would it have been any different?

Does it make you feel guilty at all, as if you should always be learning English instead of reading your home language?

There aren't many Vietnamese families who come to the museum, so **the staff here are trying to reach out more to the Vietnamese community** with these things we talked about (labels, round-boat with the hats and clothes, design of the room with bamboo and natural materials). Do you think those strategies will help to bring more Vietnamese families to the museum, or do you think they won't they be enough?
Do you have any idea why most Vietnamese families mostly don't come here?

Does it feel as if you're seeing your own culture, and talking about it with your kids, or does it feel like a museum for other people?

Do you think your children learned anything in the exhibition? Can you say a bit more about what you think they learned? Do you think they learned anything about circles, in particular? Or were they really just having a good time?

<u>When you feel done:</u>

Was anyone in your group born in Vietnam? (If so, how old were they when they came here?)

And has anyone else visited Vietnam? (talk a bit about that, to get an idea of how much they know the country.)

How much do the different people in your group speak Vietnamese at home, and how much do they speak English?

Do you mind if I ask you what zip code you live in? Is that here in San Jose?

Thanks so much for coming in today and helping us – it was great to meet you.
(Call Sue over to give them their thank-you check.)

Appendix K: Sample activities from *Secrets of Circles* Family Science Night

Family Science Nights

Gear Works

Gears are circles with teeth that transmit energy from one object to the next. Using their teeth to connect them, the turning motion of one gear is transferred to another. By moving only one gear, children can move many others, limiting the amount of effort needed to move a large number of objects.

Objective

Children will understand that the size of a gear and the number of teeth it has determines how fast it will spin.

Materials Needed

- 10 sets of Motorized Fridge Gears (can be purchased from www.scientificsonline.com), labeled with the number of teeth dot stickers
- 10 Magnetized white boards
- 10 Dry erase markers

The Process

- Before introducing the activity to children, place one dot sticker on each gear as a place holder for counting the number of turns.
- Invite children to arrange gears on a board.
- Before turning on the motorized gear, children can make a mark on the board to show where each gear is positioned. Children's marks should line up with the dot sticker on each gear.
- Ask children to make a prediction about the number of rotations each gear will make.
- Children will turn on the motorized gear, watch the dots, and count revolutions to check their predictions.

Questions to Ask

- Do you think the gears will turn at the same rate? Which will be faster, the smaller ones or the larger ones? Do the number of teeth on a gear effect its turning speed? How will you find out?
- Which gear works harder than all of the others? How do you know?

Ways to continue the learning...

Here are some additional ideas for related exploration of *gears, energy, and motion*:

- Challenge children to predict and control the direction that the final gear in a chain will spin.
- Create patterns of larger and smaller gears or gears with different numbers of teeth to test the cumulative effect of faster and slower gears.
- Explore real life applications of gears, such as car engines, bicycles, and mechanical clocks.

Standards

This activity relates to the following NSTA Science Standard for Grades K-4: *Children develop understanding of the position and motion of objects.*

Assessment

Ask children to draw a picture of the machine they created. Then ask them to explain verbally, graphically, or in writing how their machine works.

Career Corner

Mechanical engineers design tools and machines that make work easier for other people. If you like to build and take apart models and machines, you might enjoy beeing an engineer.

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Family Science Nights

Why Round?

Wheels do not necessarily have to be circles. So, why are they? In this activity, children will explore the rolling properties of different shapes attached to axles.

Objective

Children will understand that the lack of corners and points on a circle helps it to roll smoothly and to pull objects efficiently.

Materials Needed

- 10 KP roll-o-graph (a simple tool that allows children to graph the path that different wheels take, pictures and plans for creating one are included in the Blackline Master section)
- Thin colored markers
- Thin decorative wood shapes – pairs of circles, ovals, triangles, squares, and stars
- Rolls of adding machine tape

The process

- Before introducing the activity to children, drill holes into the centers of each of the shapes. The holes should be just large enough so that a marker can fit through them. Slide one marker through each pair of shapes to create an axel (the marker) with two wheels (the wooden shapes).
- Show children how to set the adding machine tape on the peg and feed it through the brackets of the KP roll-o-graph.
- Children will choose a set of wheels to test, uncap the marker, and roll the wheels along the mat so that the marker traces the path of the wheels. The roll-o-graph will create a visual depiction of the smoothness or roughness of the wheel's ride.
- Children repeat the activity with different types of wheels.

Questions to Ask

- How far is the center of each shape (the axel) from the ground as the shape spins? Is it always the same?
- Which wheel shape would you like to have on your car? Why?

Ways to continue the learning...

Here are some additional ideas for exploring *wheels*:

- Let children connect different objects of varying shapes to straws and roll them down a ramp to determine differences in speed, direction, and distance.
- Let children create different wheel shapes using clay or cardboard and experiment with how they work.
- Explore real life applications of wheels in toy cars, wagons, and pulleys.

Standards

This activity relates to the following NSTA Science Standard for grades K-4: *Children develop understanding of the position and motion of objects.*

Assessment

Ask children to design a car to match certain specifications, such as one that will roll down the ramp the fastest.

Career Corner

Construction Workers and Contractors use circles to make many tasks easier. Many complicated machines are based on the simple principles of a circle.

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Appendix L: Comments from staff at remote sites about specific exhibits

On a Roll

> Spinning Table [On a Roll] is the most popular one with staff, like the maintenance people are always setting stuff up on it. And visitors love it too, although they don't always realize what you can do with it. Once you show them the spinning, they buckle down with focus and energy. So if I go by, I'll say "Let me show you something," to get them started. Or if the person is too small to hold a disk, I'll show them with a tennis ball. Maybe it could have a drawing to help people realize what you can do there. [Ecotarium]
>
> That one was particularly clever: cleverly engineered, durable, and people loved it. I had to prime the pump each day: I'd show a few kids how to do it, and also the host in the gallery. I'd say "Hey, want to see a trick?" And I'd get something spinning, and they just loved it . It depended on the age: for young kids, I'd use a tennis ball, because anyone can get that spinning. Since I wasn't always there, a video might have helped to demonstrate, but actually it got me involved with our guests, and gave the host something that they could really work with, so maybe it was better this way. [Strong]

Circles Videos

> There were wonderful videos of the different circles, and that was lots of fun. It was rather like the Spin Pictures activity, actually; the same people would sit there for 10-15 minutes and play with that. [Strong]

Spin Pictures

> People played with that one for a long time, once they'd get hooked by it. Some younger children didn't have the patience to get hooked, but a 9-10 year old who got dragged to the museum really liked that one. [Strong]
>
> People got how they could make a circle, but without an explanation they didn't really go further. I never saw pictures other than a circle, because people didn't realize they could turn the inner turntable to get the spiral pictures. It wasn't clear why that was happening, how it was working. And that was again something that needs parental cues – parents don't like to say "I have no idea."… Maybe there could be explanations of how it works, or something to suggest to people that they should try things other than spinning it around to just get circles. [Ecotarium]
>
> Technologically it tends to forget its job and we have to restart it by hand a few times. So it's not infallible. People tried all sorts of things with it, like sticking their face underneath to get their photo. There's a magnetic turntable on top, but it tends to exhaust quickly, so people don't get those really cool Spirograph flowers. Or if it tends to sit in the middle of the table, people don't get it. But I always saw people use it and love it, and it showed what it was intended to show. [Ecotarium]

Build an Arch

There weren't a lot of parental cues for that one, and lots of kids asked why the bridge worked, or how it worked, and parents didn't know how to answer that. They were just happy that it worked, but kids want to know why. Maybe the text was kept very minimalist because of the three languages, so it would make sense [not to have explanations]. [Ecotarium]

Ripple Table

The Ripple Table was really an elegant piece – I think it was Zach Simpson who designed that. It was beautiful, and I saw the kids really using it, which was nice. Actually, it was an example of the craziness here: when we're busy, it became whack-a-mole, but on quieter days it was zen-like, and they'd really appreciate it. [Strong]

People using the Ripple Table didn't seem to get the point. They thought the object was to hit the dragonflies as hard as they could. There wasn't much signage on that one, if I recall – maybe the way it was set up, that's just what people are going to do. But I saw lots of banging with the wands, by people of all ages. I explained to them that you don't have to hit it hard, but one woman told me it doesn't work if you don't hit it hard. And it did take a little while to get up and running, and it had some kinks – one wand wouldn't work, etc. Maybe some of that was wear and tear because people hit it so hard. That was the one part of the whole thing where I just felt was over people's heads or they didn't see the point. People would play for a few minutes and see that it wasn't' doing anything different, and they would walk away. As opposed to [On a Roll], where they'd try balancing the balls, or the rings, ,and keep changing and evolving. Ripple Table did just one thing. [Ecotarium]

Compass Table

The Compass Table had really neat [fluorescent] material; I think [when we build our own exhibits] we'll use it for something else around here. [Strong]

Kaleidoscope

I liked the kaleidoscope, how you could move the mirror, and it was visually interesting.

Book Bench

The Book Bench we put in a back corner, which seemed natural for quieter space. We're part of the local library, so guests are used to being able to check out books. And it encourages repeat visits. I thought that worked. It wasn't as well attended as some of the others, but you need that end of things as well – to let people dig deeper, encourage them to read up on what they just saw. [Strong]

We've got those in our permanent collection, so people can take them home. CDM provided a full set; I think they were ours to keep. It's nice for those few kids who are interested, even if it's only 5% that want to pick up a book, check one out, take one home.. I wouldn't expect it to have high traffic, but it's great to have it here. [Strong]

-I don't see people using the library much. I think it has to do with the energy of the exhibit, having noticed that with other exhibits I've made. Each exhibit invites a certain kind of behavior or energy. [Ecotarium]

For the first half of its stay here I didn't see anyone using it, but I was finding the books throughout the museum. Toward the end, I did see a mother reading to her son, though I don't recall which book. And for our preschool morning we used Color Zoo, and the kids loved it. So they were getting looked at, but the only reason I knew was that I would find them all over the museum. [Ecotarium]

Family of Circles

I would have liked more signage for that one. I'm not sure people even know what a torus is, so it might have been nice to add a bit more information there. I don't remember if there was more signage, but I remember wishing there was a bit more. [Strong]

Lathe

We had durability issues with the lathe. People didn't know how to use a treadle -- maybe it's a lost skill. I saw a lot of people stomping on that. But on the other hand, I don't know how else you'd do it. Maybe you could do signage somehow. Or maybe it's an opportunity for a mother to explain how to do it, and a little problem-solving isn't a horrible thing either. [Strong]

Giant Tire

The Giant Tire was hard to get going, and then once it did get going, it had a lot of momentum, so it was tricky. [Strong]

Appendix M: Comments from staff at remote sites about specific supporting materials

Website

Some of the websites listed on p.12 of the brochure (where it says "Enjoy these books and websites") were useful. One of my colleagues from Public Programs looked at some of them, and said they were helpful for rounding out our knowledge, plus they were a springboard for other ideas. [Strong]

Exhibit descriptions

We did get a binder with descriptions, that we used to get a feel for the exhibit. [Ecotarium]

Program descriptions and activity materials

We've done some different programming with it, although the materials came late and we didn't know they were coming. But they've been really nice to have. [Ecotarium]

At first we didn't have them or maybe we didn't know we did, so we didn't use them a lot. Toward the end we had a specific events weekend for our members, and we took out some of the supplies. [Ecotarium]

We used some of the materials that came with the exhibition for our members' weekend, which was very low-key, with a free train guide, and we had a volunteer doing the Spirograph, that sort of thing. [Ecotarium]

I did look at those, and planned on doing some, but time didn't allow. I particularly liked the look of Reinventing the Wheel, which went along with the exhibit that had cars and a track of their motion; I thought that would work well as a program, but I didn't have time to get the supplies, and it didn't really fit our program schedule. [Ecotarium]

We don't do night-time things, and most of the kids are very young, so they don't have the attention span to do a half-hour activity. They seemed well designed, and there was a specific program for a parent and child working together, which would have worked well, but we weren't set up for doing that. [Ecotarium]

The Education Team read them to get a sense of what was available in the exhibit and to plan our school-break week program and Circle Saturday activities. There were 8 circle–themed Saturdays during the run of the exhibit. [Strong]

Marketing materials

We don't recall seeing all of the press elements you describe above. We do recall receiving artwork piecemeal as we asked for it. Perhaps press materials were created after our creative deadlines had already passed or after we had the exhibit at our venue? [Strong]

I remember things getting to me late, and not having a template for ads, and having them send me stuff piecemeal, and being told I could use some things I wanted to use. I was doing it in the dark, and I asked for some of the images of round things: flowers and cookies and buttons from their education materials, and they sent them to me but they said I couldn't use them. I wanted to put them in my ads, but they didn't like that, so I removed them. Plus a main image was a tire, and the bottom of the tire showed, so I had a little trouble silhouetting the image to use... It could have been more organized and together. Earlier and more complete would have been nice. But I know how it goes. We finally got what we needed – and that often happens with traveling shows, especially at the beginning of a show, I understand, I go with the flow. I think we were the first venue. [Strong]

Would have been helpful to have had ad templates and rules for ads that were clear. [Strong]

We did use what CDM sent – it was useful. Our marketing materials looked like what came with the exhibit: the purples, the green, the picture of the tire they sent us, the logo. I remember there were challenges about that, though I don't know the specifics. A large part of the space needed to be taken up by the funders that came with the exhibit: CDM, NSF, and so on. Normally we just do a little rack card, so we aren't used to the logos taking up so much space. So I remember struggling with that a bit. [Ecotarium]

The way I read the contract, it required us to use the rack cards, instead of creating one of our own. And that was problematic for us. It wasn't that strong a design, and there were elements I needed to change for our Ecotarium design standards, so I swapped some things around, and it went fairly smoothly, but it was restrictive to have to use that design… The ads had a similar design to the rack cards. I wasn't crazy about them, but did use them [Ecotarium]

They had some nice color photos that were very helpful. And I took more as well…It would be nice if they included more action photos, more dynamic photos… People learn while being entertained, but what's getting them in the door is what they're going to do. So finding the action photos and things that really were hands-on, that was the best way. In the existing materials there are pictures with people in them and some are using exhibits, but it's not easy to tell what they're doing. Some were quite good, but some were posed. The ones that were used in the rack cards were more posed of kids sitting smiling, which is fine, but I was looking for dynamic pictures of people have fun at the exhibit, and actually using the components. [Ecotarium]

Something helpful that's not in the materials: we do a lot of radio advertising, so I created a more creative radio script. And the other thing we tried to get but couldn't was video footage, that we could use on our website [and cable channel ads]. [Ecotarium]

I found the website particularly useful. I prefer to do things that way, actually. The Ecotarium has off-site designers, so it's much more efficient to be able to point them to the website and tell them what we need. [Ecotarium]

In terms of the marketing materials, there were already translated press releases, which were very helpful in terms of hitting press in those communities, and the Latino community had active media representation. The Vietnamese community didn't, but I used the press releases to communicate with leaders in those communities, by sending them out by email . Actually, it would have been better if we could have had a flyer in those languages too, just a one-pager. We had a designer make one in Spanish, though not Vietnamese because we had trouble finding a translator. [Ecotarium]