

Chabot Space & Science Center Touch the Sun Exhibition

Summative Evaluation
Final Report August 2013



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***Touch the Sun* Exhibition – Summative Evaluation Report**

Introduction

Touch the Sun is an 1100 square foot exhibition supported by the National Aeronautics and Space Administration (NASA) under Grant No. NNX12AE29G issued through the Education & Public Outreach for Earth & Space Science (EPOESS) Program. It opened at Chabot Space & Science Center (Chabot) in January of 2013. Chabot staff contracted with Wendy Meluch of VisitorStudies.com to design and conduct a summative evaluation of *Touch the Sun*. The two-pronged research design employs an exit survey and an observational study; it was submitted for IRB review and was granted an exemption (Appendix A).

This document describes the summative studies and reports results and findings. Many representative, verbatim comments from exit surveys are presented. Also included are excerpts from observation notes made by data collectors.

Description of Exhibition (provided by Chabot staff)

Big Idea: *The Sun is a dynamic and ever-changing object in space, and modern scientific observation of it reveals intricate details of its cycles of activity, giving us great insight into the many ways that the Sun's behavior affects the Earth.*

The exhibition *Touch the Sun* showcases the stunning state-of-the-art imagery of the Sun captured by NASA's Solar Dynamics Observatory and streamed to Chabot in near-real-time. Central to the exhibit is a fully interactive, 90-inch display presenting animations of the Sun's atmosphere in astounding detail. Visitors interact with the live Sun by zooming and panning the animation to explore features like solar flares, prominences, and magnetically active regions that bring the Sun to life. Visitors may select different layers of ultraviolet imagery to blend and mix different features and layers of the solar atmosphere.

Touch the Sun has additional exhibits that give visitors a hands-on experience with the forces of nature that shape the Sun's behavior. A Ferrofluid exhibit lets visitors explore the interaction between magnetic fields and magnetic material, as with the solar magnetic fields that affect plasma to form features like sunspots. A 20-inch Plasma Globe offers visitors the chance to manipulate the fourth state of matter, plasma, present in the Sun and in every neon sign. Digital drawing stations let users explore detailed solar imagery through the act of drawing features like sunspots and magnetic loops and arcs, producing hand-drawn animations that reveal dynamic change in solar magnetism and the rotation of the Sun.

A solar art gallery presents cultural solar imagery and the mythology of the Sun from several different cultures, and a wall-sized mural of the Sun-Earth connection presents a birds-eye view of the two most important objects in the Universe, to humans, and the bonds that connect them.



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Findings

To what extent do casual visitors to the *Touch the Sun* exhibition perceive intended messages as stated in the Big Idea?

Big Idea: *The Sun is a dynamic and ever-changing object in space, and modern scientific observation of it reveals intricate details of its cycles of activity, giving us great insight into the many ways that the Sun's behavior affects the Earth.*

Across all surveys, 75% of respondents touched on one or more of the main themes of 1) the complex workings of the sun, 2) the special ability to see and know about the sun, and 3) the sun's relationship to the Earth and/or humans. Please also see Serrell's 51% Solution below for more context to understand this strong positive finding.

Respondents were clear that *Touch the Sun* conveys broad and detailed information about the dynamic and ever-changing nature of the sun. About one third of survey respondents (34%) emphasized this when describing what they think the exhibition is about. Typical visitor comments refer to *how the sun works*, and/or described the sun as *active, dynamic, and/or complex*. Several people also listed more detail, e.g., *plasma, flares, magnetism, sun spots and fluidity*.

While survey respondents did not specifically refer to the technology that makes these images and new sun-related knowledge possible, they gave emphasis to the fact that *Touch the Sun* affords people the opportunity to see the sun in a special way. About one fifth of the sample (19%) referred specifically to the opportunity to see things that are *not usually visible*, often commenting on seeing *what the sun is like*, seeing it *in real-time* or *close-up*.

Over one quarter of respondents (29%) understood the main point of the *Touch the Sun* exhibition to be to get people excited, interested or appreciative about the sun. Comments evidence the respondents' own sense of awe or excitement, and/or state that the exhibition is intended to help get people interested in the sun. These respondents found the sun to be *awesome and amazing*; the exhibition inspired *interest* and *wonder*.

A small, but significant number of respondents (13%) emphasized themes of how the sun relates to Earth or humans.

What lessons do casual visitors take away from *Touch the Sun*?

Exit survey respondents wrote about new ideas they had gotten at the exhibition, and/or things that the exhibition reminded them about. A very large majority, 92%, had at least one item to share. Please see Exit Survey Results below for more detail.

- Visitors learned about plasma. (21%)
- Visitors learned about the sun's magnetic poles. (15%)
- Visitors learned that the sun is dynamic and complex. (13%)
- Visitors learned about various physical attributes of the sun (flares, coronal holes, etc.). (25%)
- Visitors were awe-struck by the sun. (12%)
- Visitors were impressed with how much there is to know. (10%)
- Visitors were impressed by the ferrofluid. (10%)
- *Visitors learned that the sun has many colors.* (8%)

The idea that the sun has many colors deserves attention. Four survey respondents specifically referred to the colors of the sun when describing new ideas that they got from the exhibition.



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Their brief comments do not make clear that they understood these to be colors not usually visible to humans. Similarly, observation during the Tracking and Timing study tells us that using filters on SDO images makes a big impression on users because of the colorful display, but not everyone understands what they are seeing. We heard a few people wonder out loud about the filters (*I thought the sun was yellow*), and though we did see some people reading related content, we did not overhear any groups discussing why the filters affect the color of the image.

How are the exhibition and individual components used by casual visitors?

Observational data tell us that *Touch the Sun* is used quite thoroughly. Naturally, most attention was given to the four interactive components which are the main features of the exhibition. About one third of the sample we watched used all four interactives (36%). Nearly half of the visitor groups we watched attended four or more components, including murals (44%). The two large murals are off the beaten path and got little attention compared with the interactives. Please also see Serrell's 51% Solution below for more information about understanding thorough use of exhibitions.

SDO Panel & Screen

The SDO component is what stood out most often for survey respondents as they reflected on their visit (44%). People found the images to be *exciting, amazing, beautiful* and the like. Observation data confirm this enthusiasm among visitors, particularly for filtered images. We also noted that visitors had a fairly easy time using this interactive, and frequently discussed familiar events such as the transit of Venus. Parents typically pointed out plasma events or other solar features to their children.

The SDO panel and screen installation was attended by 68% of visitor groups in the observation study, and was the first stop for 24%.





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Plasma Globe

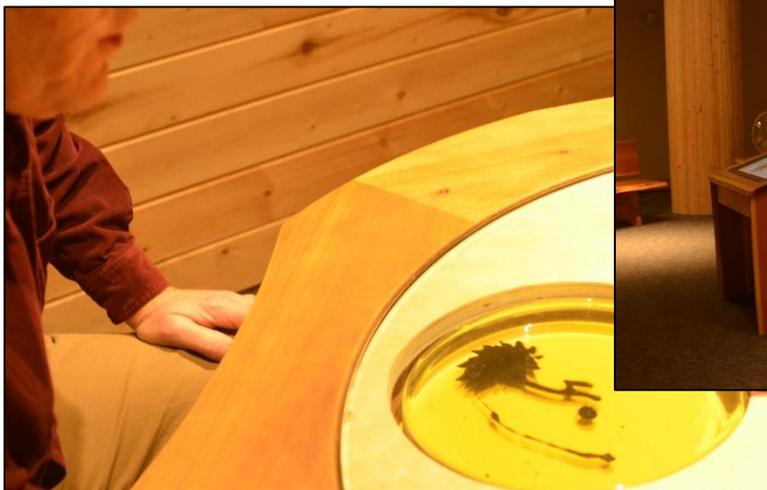
While the Plasma Globe stood out less often for survey respondents (31%) than did the SDO display, it was by far the most attended element in the exhibition. Almost every visit group in our observation sample used the Plasma Globe (96%), and for half of the sample this was the very first element they engaged with. Its popularity with children accounts for some of this strong attractive power as they can see it more easily than some other elements and often run directly to it, followed by their adult companion(s).

The Plasma Globe is easy to approach and interact with, and generates lots of communication among users. People of all ages freely and naturally played and experimented with it, sometimes making up games with other visitors in their social group. Adults sometimes had to encourage or reassure children about touching the globe (*it won't hurt you*), and often read the label or otherwise narrated the experience while others in the group were busy touching the globe and watching the plasma. Some visitors that we watched discussed the fact that this was plasma, but only one was overheard to make an overt connection to the sun.



Ferrofluid Interactive

The Ferrofluid Interactive stood out as a highlight for a quarter of the survey respondents. For them, playing with the ferrofluid was *fun, cool, surprising*. A few noted that they had not been clear about how to start with the component. We observed this in the Tracking and Timing study as well; visitors often had to take a moment to find the magnets and figure out how to proceed. Once they got started, visitors were clearly entertained and engrossed in the activity. This is where we most often observed users calling other members of their party over to join them, verbal interaction, and extended dwell times. This component was attended by 74% of the observation sample; it was the first stop for only 8% probably due to its location and low profile.





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Galileo Stations

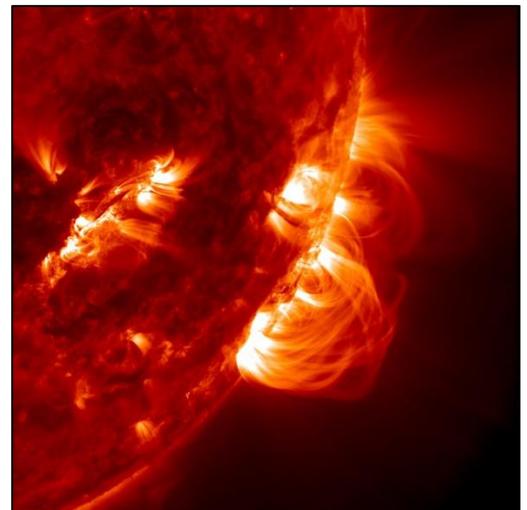
These three interactive screens were the least likely to stand out for survey respondents (10%), who found them to be fun to use. Though they were the least often visited of the interactive elements in the observational study, they commanded a very high attraction rate of 58%. Those who did choose to attend the Galileo Stations made fairly thorough use of them: 41% used two, 28% used all three; 45% completed and then watched animation(s). Some users, usually children, had difficulty getting the screens/programs to behave, but most of them quickly succeeded, often with the help of an adult. Frequently, a child initiated time with the Galileo stations by scribbling on one of the screens; often an adult joined the child, restarted the program, read and guided the child's interaction with it. It seems to provide a pleasant, low key, shared activity for adults and children, though adult pairs were observed to use it as well.



What about the exhibition and/or which exhibit components generate excitement and awe in casual visitors?

Touch the Sun as a whole seems to interest visitors and get them excited about the sun. Indeed, 29% of survey respondents felt that this was the exhibition's primary purpose. Over the course of the survey, a large majority of respondents evidenced engagement and/or expressed excitement about *Touch the Sun* at least once (62%). Participants found exhibit content and components to be *amazing, mesmerizing, awesome, fascinating, dynamic and exciting*. In the survey data, enthusiastic reactions to content most often seem to be associated with SDO images, followed by the plasma globe and the ferrofluid interactives.

Casual visitors in this study were very moved by the SDO images; respondents most often named this as a highlight when reflecting on their exhibition experience on the survey. While the SDO images were compelling, mesmerizing, even awe inspiring, they didn't appear to generate playful or physical excitement. The Plasma Globe and Ferrofluid components are physically dynamic, and more viscerally responsive to visitor interaction than the SDO installation. Visitors using the globe and ferrofluid elements were noticeably chatty and playful with each other and the exhibit(s). Ferrofluid is especially fascinating, engrossing visitors and generating extended dwell times. In contrast, the Galileo Stations are low key and pleasant. They don't top the list for many visitors, but they are well used and visitors enjoy them, and get information from them.





Exit Survey Results

What messages do visitors perceive in *Touch the Sun*?

Touch the Sun is about how the sun works. (18; 35%)

When describing what they perceived as the intent of the *Touch the Sun* exhibition, respondents most often made some reference to *how the sun works, behaves, or acts*. Typical visitor comments described the sun as *active, dynamic, complex*. One person interpreted the sun as a *living entity*.

The exhibit is to show... to make people...

- *Various ways the sun works. Understand how the sun functions*
- *Think about how the sun works.*
- *Understand and appreciate what is going on in the sun.*
- *The sun is an active and amazing thing.*
- *Sun's activity and the sun's structure*
- *Understand that there is so much activity going on in the sun all the time.*
- *The dynamic nature of the sun.*
- *Appreciate the fluidity and complexity of the sun.*
- *How the sun isn't just an amorphous blob.*
- *Far more aware that the sun is a living entity. It moves, it breathes.*

This exhibition gets people excited, interested, and appreciative. (15; 29%)

Clearly this exhibition inspires interest and awe in visitors. Respondents referred to this almost as often as *how the sun works*, when commenting on the main purpose of *Touch the Sun*. Comments evidence the respondents' own sense of awe or excitement, and/or state that the exhibit is intended to get people interested in the sun.

The exhibit is to show... to make people...

- *How awesome the sun is.*
- *How amazing and small we are to the universe and how incredible the sun is.*
- *Wonder and question*
- *Excited about solar astronomy and space.*
- *Understand the sun and find it interesting.*
- *Want to know more about the sun.*

This exhibition gives people a chance to see the sun in a special way. (10; 19%)

Quite a few visitors gave emphasis to the opportunity to see *what the sun is like*, see the sun *close-up* or in *real-time*, though they did not reference the technology which makes this possible.

The exhibit is to show... to make people...

- *A much more close-up of what we would not normally see. I loved it.*
- *more aware of what the sun actually looks like.*
- *The surface of the sun.*
- *Sunspots and solar phenomena not usually visible.*
- *An interactive way of viewing the sun*
- *What the sun is like in real time.*



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Other Touch the Sun messages vary.

Several respondents referred to the substance of the sun, what it is made of, or plasma (7; 13%). An equal number gave emphasis to the relationship of the sun with Earth or with people (7; 13%). Other messages or themes identified by survey respondents include magnetism or magnetic fields (4), flares (3), or other specific phenomena (6).

The exhibit is to show... to make people...

- *Think about what the sun actually is.*
- *Different aspects of the sun's composition.*
- *Magnetic effects on plasma*
- *Magnetic fields in action*
- *How solar flares happen and what they are made of.*
- *Solar flares on the sun. Think about magnetic flares.*
- *Aware of the sun as our energy source.*
- *How amazing and small we are to the universe and how incredible the sun is.*
- *Aware the sun is important to all life*
- *The effect of the sun's activity on the earth.*
- *How the sun and energy helps sustain our planet*
- *Realize that the sun has different particles and colors*

What are visitors learning in *Touch the Sun*?

In respondent comments about new ideas that they got from the exhibition, or things that it reminded them about, we see the same themes that respondents used to describe the purpose of *Touch the Sun*. In addition to learning about plasma, magnetism, sun spots, flares, or other solar-related phenomena, respondents waxed philosophical. They reflected on the awesome nature, size and power of the sun, or about how much there is to know and/or how little they feel that they know.

Visitors learn about plasma. (11; 21%)

Respondents described various aspects of plasma that were new to them, including that it is the fourth state of matter, that it makes up the sun, and that it is contained in the plasma globe. One person also noted the speed of plasma; another compared plasma to ferrofluid.

- *Plasma was a 4th state.*
- *The sun is made of plasma.*
- *The plasma globe was plasma. I always thought those were 100% electricity.*
- *Plasma follows the path of least resistance.*
- *The speed of plasma, i.e. the solar wind.*
- *Plasma in a magnetic field is similar to a ferrofluid.*

Visitors learn about the sun's magnetic poles. (8; 15%)

Awareness of the presence of magnetism on the sun ranged from the simple fact that the sun has magnetic fields to the notions that those fields cause activity, and that the sun has many more than are found on Earth.

- *The sun has magnetic fields*
- *Magnetic fields play such a significant role in solar activity.*
- *The sun has multiple magnetic poles on the surface*
- *The sun has multiple poles of magnetism unlike our Earth.*



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Visitors learn that the sun is dynamic and complex. (7; 13%)

Several respondents reflected on the sun's complexities and/or dynamic action.

- *How complex the sun is in the universe.*
- *The sun is very dynamic.*
- *How fluid and active the sun is. Things are happening/ changing all the time*
- *The sun is full of activity and that the majority of that activity occurs in light spectrums invisible to the naked eye.*

Visitors learn that the sun has many colors. (4; 8%)

Four respondents specifically referred to the colors of the sun when describing new ideas that they got from the exhibition. Their brief comments do not make clear that they understood these to be colors not usually visible to humans.

- *The sun had so many colors.*
- *The sun could be so many different colors. (child)*
- *The sun changes colors.*
- *The sun comes in a variety of different colors. (child)*

Visitors learn about various physical attributes of the sun. (13; 25%)

Other sun-related lessons focus on various features such as sun spots (4), flares (3), coronal holes (2), the size of the sun compared to Earth (2), the sun's temperature and/or its relationship to other planets

- *Sunspots were cooler than surrounding areas*
- *Sunspots are big!*
- *About coronal holes and how they affect solar winds*
- *Coronal holes - plasma escapes the sun.*
- *Even tiny solar flares are huge compared to the size of Earth*
- *Size comparison of the sun to Earth.*
- *The temperatures on the sun are up to 20 million degrees Celsius!*
- *Earth and Mercury block the sun and Venus and the Moon.*
- *The sun is a star, not a planet*

Visitors are awe-struck by the sun. (6; 12%)

Respondents were moved to ponder the enormous size, power and beauty of the sun, sometimes commenting on how tiny we humans are.

- *The immense power of the universe and how miniscule we are!!*
- *The sun is incredibly beautiful.*
- *The sun is extraordinary! For the first time I have seen what I've only heard about*
- *We are incredibly tiny*
- *We are a very small part of the universe*

Visitors are impressed with how much there is to know. (5; 10%)

Several respondents commented on how much there is to know about the world, how little they know, and/or that they want to know more.

- *There is a lot I don't know.*
- *There is so much I still want to learn.*



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Visitors are impressed by the ferrofluid. (5; 10%)

When commenting on new ideas that they encountered in *Touch the Sun*, most people responded to the images, but a few specified something about the ferrofluid. They found it to be just plain *cool* or made observations about the way it behaves.

- *The stuff that looks like olive oil was so cool.*
- *Ferrofluids have an evil aesthetic.*
- *Ferrous liquids are super cool!*
- *Magnetized liquid would behave so much like iron filings.*

What stands out for visitors?

SDO Panel & Screen (23; 44%)

By far what stood out the most for these *Touch the Sun* visitors were the SDO real-time and archived images. People found the images to be *beautiful, amazing, inspiring, mesmerizing, the coolest*. They appreciated what they considered to be a rare and unusual opportunity to see these images. Respondents often noted the very large size of the screen, the close-up, detailed images, and the filters that they can manipulate.

- *The amazing images!! Absolutely awe inspiring.*
- *The big screen in the middle with the filters is the coolest.*
- *The huge screen and peaceful music. I wish I had this at home.*
- *The solar imaging, because it was closest to mainstream astronomy, which is near and dear to my heart.*
- *The images/ feed of the sun since we can't see the intricacies otherwise.*
- *The observatory (sun's image today) because it's not something you can see everyday*
- *The TV because it shows current photos of the sun.*
- *The up-close view of all the different activity on the sun.*
- *The sun flare display. It's very mesmerizing.*
- *The coronal mass ejection photos*
- *Filter selection on sun's different energy and temperatures.*
- *The interactive data set on the large monitor, where I would overlay various visualizations. It was definitely something I hadn't explored before.*
- *Loved the main film showing the sun filters you can apply to understand what is going on.*
- *I love your Touch the Sun exhibit. The TV screen was spectacular. Is this on any type of website? My son loved watching it. I, myself, could watch this by the hour. The high definition was amazing. Filtering it was only icing on the cake...fantastic.*

Plasma Globe (15; 31%)

The plasma globe stood out for quite a few visitors. The globe is *cool, fun, interesting, amazing*. Some people were very enthusiastic about it; the globe is *off the charts*.

- *The electrical sphere was off the charts.*
- *The energy from the sun to your hand [plasma globe]*
- *The plasma, definitely the plasma. I had no idea what it was, but it amazed me.*
- *I liked the plasma globe -- it is cool!*
- *Plasma globe. It's cool for little kids.*
- *The plasma globe. It is sooo cool.*
- *The plasma globe. It demonstrates the plasma generation most dramatically.*
- *Plasma globe. Dramatic and fun to interact with. Kids love it.*



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Ferrofluid (13; 25%)

The ferrofluid interactive was a favorite component for about the same number of people as the plasma globe. Like the globe, ferrofluid is *cool, amazing, and fun*.

- *Ferrofluid. Fun, easy, surprising, and attractive. Hard to figure out what to do - put signs on the table indicating we should reach below.*
- *Ferrofluid :)*
- *Loved the liquid magnet table.*
- *The ferrofluid exhibit is neat*
- *The ferrofluid, very good for kids.*
- *The ferrous liquid exhibit - so fun for the kids and adults. Even the toddler liked it!*
- *The magnet table, because of the fascinating way the magnetic fluid behaves.*
- *The stuff that looks like olive oil was so cool. It provides an entertainment outlet and a learning opportunity.*

Galileo Stations (5; 10%)

Least often mentioned as a highlight were the Galileo stations. Respondents who listed them liked being able to interact or draw, and they liked seeing sun features in detail.

- *I like the interactive screens. The interactive elements are the best.*
- *The touch screens are nice because of the interactive nature but it is not very user friendly.*
- *The part where I get to draw, because I want to be an artist when I grow up*
- *The sun spots because it shows different shapes on the sun.*

Does the exhibition engage and excite visitors?

A majority of respondents evidenced engagement and/or express excitement. (32, 62%)

Over the course of the survey, a large majority of respondents evidenced engagement and/or expressed excitement about *Touch the Sun* at least once. They commented on the exhibition as a whole, or more often, about a specific aspect of it. Visitors found exhibit content and components to be *amazing, mesmerizing, awesome, fascinating, dynamic* and *exciting*. Enthusiastic reactions to content most often seem to be associated with SDO images, followed by the plasma globe and the ferrofluid interactive.

- *The amazing images!! Absolutely awe inspiring.*
- *The sun is extraordinary! For the first time I have seen what I've only heard about.*
- *The sun is incredibly beautiful.*
- *How awesome the sun is.*
- *The immense power of the universe and how miniscule we are!!*
- *How amazing and small we are to the universe and how incredible the sun is.*
- *The sun flare display. It's very mesmerizing.*
- *The plasma, definitely the plasma. I had no idea what it was, but it amazed me.*
- *The plasma globe. It is sooo cool.*
- *The part with the metallic olive oil. It provides an entertainment outlet and a learning opportunity. The stuff that looks like olive oil was so cool. The electrical sphere was off the charts.*
- *The magnet table, because of the fascinating way the magnetic fluid behaves.*
- *[Purpose of Touch the Sun is to get people] Excited about solar astronomy and space.*
- *[Purpose of Touch the Sun is to give] A much more close-up of what we would not normally see. I loved it. [To make people] Far more aware that the sun is a living entity. It moves, it breathes.*



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- *I love your Touch the Sun exhibit. The TV screen was spectacular. Is this on any type of website? My son loved watching it. I, myself, could watch this by the hour. The high definition was amazing. Filtering it was only icing on the cake...fantastic.*
- *This is excellent*
- *This is my favorite place in the museum.*
- *I like this better than the Bill Nye exhibit.*
- *There is so much I still want to learn.*

Exit Survey Sample Description

Group Size	Count	% (n=52)
1	3	6%
2	11	21%
3	14	27%
4	15	29%
5+	9	17%
Group Makeup	Count	% (n=52)
Adult(s) + Child(ren)	35	70%
Adults Only	9	18%
Adult Alone	3	6%
Adult(s) + Teen(s)	3	6%
Teen(s) + Child(ren)	1	2%
Respondent(s) Age	Count	% (n=56)
8-12	10	18%
13-18	2	4%
19-25	2	4%
26-59	36	64%
60+	6	11%
Respondent(s) Gender	Count	% (n=56)
Female	29	45%
Male	27	48%

Prior experience which helped respondents understand Touch the Sun. (20; 39%)

Visitors who felt that something in their background or training helped them understand the exhibits in *Touch the Sun* are fairly evenly divided into three groups:

- young students or other people who have an interest in things astronomical, but do not describe themselves as enthusiasts,
- enthusiasts, or people who are actively taking classes, or pursuing astronomy as a hobby, and
- professionals in science, engineering or education.



Tracking & Timing Study Results

Exhibition Dwell Time

Dwell Time in Exhibition	Minutes (n=50)
Minimum	1
Median	6
Mean	7
Maximum	25

How many exhibit components do visitor groups use?

Total number of components used by visit groups	Count of Visitor Groups	% (n=50)
1	3	6%
2	9	18%
3	16	32%
4	14	28%
5	7	14%
6	1	2%

Number of Components Used (Max, Min, Median, Mean)	Based on 6 (includes murals)	Based on 4 (excludes murals)
Minimum	1	1
Maximum	6	4
Median	3	3
Mean	3.32	2.96

Attractive Power of Interactive Components

The Plasma Globe stands out as the strongest attractor among the four interactive exhibit components. Almost every visit group in this sample attended the Plasma Globe (96%). It was the first exhibit attended by 50% of groups; this is true even for a majority of the visitors who entered the gallery by the stairs which is at the opposite end of the space.

The Ferrofluid interactive table was attended by 74%. This element was the first item visited by only 8%, probably an artifact of its low profile and recessed location. The SDO component was watched or used by 68%, and was the first one attended by a quarter of the sample (24%). Visitors can glance at the SDO images without stopping at it or engaging with the panel. Over half of the groups we observed watched or used at least one Galileo Station (58%).

Visitors who enter the gallery by the elevator almost always make their first exhibit stop at either the Plasma Globe or the SDO component. Stair users were as likely to cross the entire space to reach the Plasma Globe first as they were to attend any of the other components first.



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Component Attraction Rate	Number of Visit Groups to Engage	% (n=50)
Plasma Globe	48	96%
FerroFluid Interactive	37	74%
SDO Panel and Screen	34	68%
Galileo Stations	29	58%
Solar Icon Mural	9	18%
Sun Earth Mural	5	10%

First Component Attended	Number of Visit Groups to Engage this First	% (n=50)
Plasma Globe	25	50%
SDO Panel and Screen	12	24%
Galileo Stations	7	14%
FerroFluid Interactive	4	8%

How do visitors engage with interactive exhibit components?

The graph on the following page shows the percentage of component users observed to engage in a variety of behaviors. In every case the most common behaviors we observed were: using the exhibit as intended, discussing it with others, and reading the related label. The Plasma Globe and Ferrofluid elements appeared to be the most effective at generating conversation among visitors within a social group. People were most likely to take pictures at the Plasma Globe; and most likely to call others over to join them at the Ferrofluid Interactive.

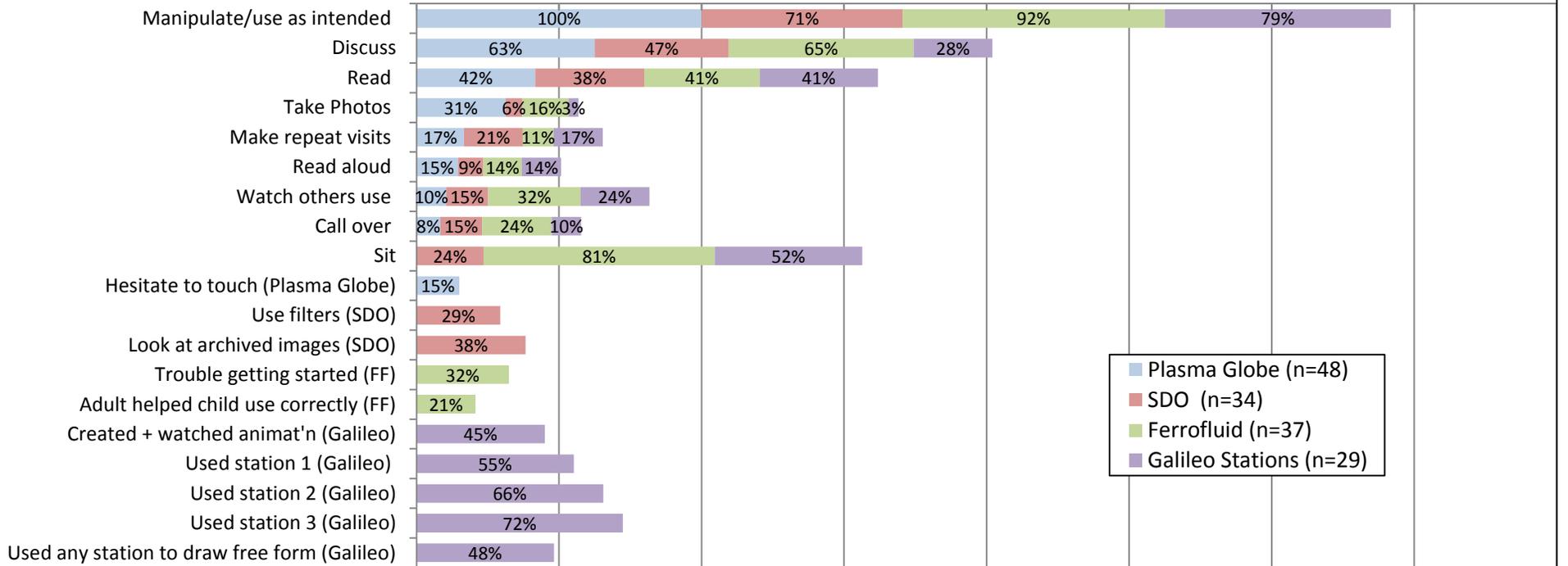
Plasma Globe

People seemed to have an easy time engaging with the Plasma Globe, and each other, to explore the active plasma within. The few who at first hesitated to touch the globe were usually reassured by an adult that they wouldn't get hurt. Many people automatically reached out to touch the globe. Often parents directed children to do so and then encourage them to watch the reaction. Typically, an adult read the label as children or other group members touched the globe and watched the plasma.

- *Dad: "Did you see how your body made that react?"*
- *Mom: "Look how the ball in the middle is spinning." Boy: "It's really interesting."*
- *Girl: "That's fire in the middle."*
- *Female: "I am the path of least resistance."*



Visitor Behavior at Interactive Exhibit Components



	Used any station to draw free form (Galileo)	Used station 3 (Galileo)	Used station 2 (Galileo)	Used station 1 (Galileo)	Created + watched animat'n (Galileo)	Adult helped child use correctly (FF)	Trouble getting started (FF)	Look at archived images (SDO)	Use filters (SDO)	Hesitate to touch (Plasma Globe)	Sit	Call over	Watch others use	Read aloud	Make repeat visits	Take Photos	Read	Discuss	Manipulate/use as intended
Plasma Globe (n=48)										15%		8%	10%	15%	17%	31%	42%	63%	100%
SDO (n=34)								38%	29%		24%	15%	15%	9%	21%	6%	38%	47%	71%
Ferrofluid (n=37)							32%				81%	24%	32%	14%	11%	16%	41%	65%	92%
Galileo Stations (n=29)	48%	72%	66%	55%	45%	21%					52%	10%	24%	14%	17%	3%	41%	28%	79%



Touch the Sun Exhibition – Summative Evaluation Report

Individuals readily tested the plasma's behavior by touching the globe with one or two hands, palms, finger tips, rings, dragging their fingers along the surface, etc., and one little girl even used her head. Pairs and groups of people naturally worked together to experiment with the plasma. They took turns putting one or all hands on the globe, and the like, sometimes making a game or contest of it, e.g., whose hand will the plasma go to first.

- *Girl: "I wonder what happens if we all put our hands on it at the same time. Let's try it."*
- *Boy: "I get less energy with a finger and more with my whole hand."*
- *Observer notes: Pretending to shock each other. Having contests to see whose hands the plasma will be attracted to. Decide plasma likes Dad's ring. Girl wants to do a test. Repeat counting to 3 to see whose hands the plasma goes to.*

Conversation often addressed touching the globe and not getting shocked. People sometimes wondered why they can't feel a shock through the glass. Others chose to tease their friends/family members about it in a friendly way.

- *Boy: "How come you can't feel it?" [No one ever answered his question even though he repeated it several times]*
- *Boy: "I'm not getting shocked"*
- *Boy: "What would happen if this touches us without the glass?" Mom: "You'd die."*
- *Boy: "How's it doing that?" Dad: "You have super powers"*

Visitors often confirmed with each other that what they were seeing was plasma. Sometimes a child would announce this, other times adults quizzed children and then explained. We heard people describe plasma as the fourth state of matter, and as a gas charged by electricity. We heard a few people wonder out loud what was in the globe and then refer to the label.

- *Male: "It's gas charged by electricity."*
- *Dad: "Do you know what plasma means? It's the 4th state of matter."*
- *Girl: "What's it made out of?" Mom: "That's a good question" [read aloud text panel]. Girl: "It looks hot in there"*
- *Boy: "Hey Dad, it's plasma!" Dad: "Oh, cool!" Dad: "It's kinda cool."*

Plasma Globe users were easily engaged and had fun exploring the element alone or in groups as described above. They got excited about it too, often laughing together as they used it. Numerous adults and young people exclaimed that the plasma is "cool!"

- *Dad: "God, that's cool."*
- *"Really cool" "Neat"*
- *"It gets really warm." "It's kind of evil, like from an evil lab."*
- *Teen: "I'm touching the sun!"*

Ferrofluid Interactive

A majority of visitors had an easy time getting started with the Ferrofluid Interactive, however, about one third of the groups we observed were briefly stumped (32%). Usually the confusion centered on the location and use of the magnets; sometimes a child would find them and show the adults. More often it was the adult figuring things out and helping a youngster. One visitor was observed to look at the table, appear not to figure out how to use it, and leave.

- *Observer notes: 1st time: Dad showed boy how to use magnet and to watch the fluid move. Boy wanted to try the magnet at each section. Dad walked around table helping as needed. 2nd time: Boy able to move the magnet on his own. Dad reinforced that he was doing it correctly.*
- *Observer notes: 1st time: Took a minute to figure out how to use. Put head under table to figure out how to use magnet. 2nd time: Boy showed Dad how to use.*



Touch the Sun Exhibition – Summative Evaluation Report

- *Observer notes: Child looking under the table. Mom shows child how to use magnet. Mom watches child use magnet.*
- *Observer notes: Looking under table. Mom read the label aloud. Mom finally figured out how the magnets work and showed daughter.*

Once they got going with the magnets, ferrofluid users got excited and called others over to join them. This exhibit is where we saw the most calling-over behavior. Users were engrossed while manipulating the ferrofluid. Some groups sat silently, each member absorbed by the activity. Other users excitedly shared with each other about the shapes they were making, or challenged each other to try different shapes or movements.

- *Observer notes: Son begins to use, calls mother over for help. Mom, "That's cool! Look at that!" She calls over other child to "see something really cool!" They laugh and discuss and play with FF. They make sounds "shump" as the fluid moves... They linger, read aloud, talk and use together. Mom, "Look guys, I'm separating all of them... I'm very excited about making a sunflower." Girl asks to go upstairs, mom, "No, we'll go in a bit, come make a sunflower." After kids wander back to SDO and Globe, mom still lingers here until son drags her over to SDO.*
- *Observer notes: 1st time: Girl calls others over and explains that it has a magnet. Each sits at their own station. Girl exclaiming for everyone to look at hers. She's trying to keep all the fluid separate. Dad reads the bold part of the label aloud. 2nd time: Both children engrossed in their own stations. Dad stands over them and watches.*
- *Observer notes: All 3 sitting at different sections of the table absorbed in their section. Continued discussion. Appear to be talking about the movement they are seeing [from hand gestures]. Child calls mom over to her section.*
- *Girl: "It makes a flower shape and a jellyfish!" Dad: "It's pretty cool, isn't it." Dad: "If I let go, it turns into a blob. If I apply pressure, it makes a shape."*
- *Boy: "You can pull the blobs all back together." Dad: "This is pretty neat actually." Girl: "Guess what I discovered? Dark Matter!!"*

There was some discussion among Ferrofluid Interactive users about the material that they were seeing or manipulating. A few related it to oil and vinegar. One person wondered if it was magnetic paint; that group read the label and still didn't understand what "ferrofluid" is.

- *Girl: "Looks like oil and vinegar. Woah! This is so cool!"*
- *Girl: "What is this? Is it oil or something?" Dad: "Maybe it's magnetic paint" Mom: "The sign says it's ferrofluid, whatever that is."*

The Ferrofluid Interactive is absorbing and gets users excited about what they are seeing. Observers most often noted extended dwell times at this element, including one person who worked with it for about 12 minutes.

- *Mom calls family over, son: "Wow!"*
- *Dad: "This is so cool! ... You can really see those magnetic lines."*
- *Male: "That's tight!" Female: "Mine is cooler." Female: "I wish the table was bigger so there could be even more fluid to move." Male: "That would be so cool."*
- *Female: "This is the best interactive."*

SDO Panel and Screen

Of the 34 visitor groups to attend the SDO component, 10 looked at the large screen without touching the panel (29%). Those who used the panel seemed to do so with ease; adults sometimes explained features, such as the zoom function, to children. Only one visitor seemed to have serious trouble - he accidentally brought up a page with additional information, seemed confused about how to bring the main screen back, and walked away from the component.



Touch the Sun Exhibition – Summative Evaluation Report

We overheard some visitors confirming with each other that on the screen were images of the sun, and a few who pointed out the current date on the screen.

- *Boy: "Is this the sun?" Mom: "Yes, it is."*
- *Dad: "Look at that picture; it's the sun."*
- *Boy: "What's in there?" [pointing towards dark areas on the screen]. Dad: "It's plasma. That's the sun. It's a projection of the sun."*

About 38% of visit groups who used the SDO interactive looked at images from the archive. The eclipse and transit of Venus images triggered conversations among visitors who remembered seeing these things themselves. Plasma activity, such as flares, were asked about by children and/or pointed out by adults.

- *Observer notes: Family starts at SDO briefly and then comes back twice for more thorough use. During the second visit, one child talks with someone from another group using SDO. While this group's mom is narrating archives, another group sees and discusses transit of Venus. Their 3rd visit is the longest, the son pulls mom away from FF to come see a picture of a wheel.... mom narrates and demonstrates zooming, filters, reads aloud, "that says Dragon Tail..."*
- *Observer notes: 2 boys played with zoom feature then had a squabble over who got to control of the screen. Dad took over panel. Directed boys to watch coronal ejections on the screen.*
- *Observer notes: Group discussion while watching transit of Venus. Boy zooms in. Watch solar eclipse. Talk about the last one they saw. Boy still engaged with panel when the rest of the group begins to leave the gallery.*
- *Boy: "An eclipse...so cool." Mom: "Remember when we saw an eclipse on our porch about a year and a half ago." "This is from June."*

Using filters on SDO images made a big impression because of the colorful display, but not everyone seemed to understand what they were seeing. We heard a few people wonder out loud about the filters, and though we did see some people reading, we did not overhear any groups discussing why the filters affect the color of the image.

- *Observer notes: Found the filters "ooooed" when the color changed on the big screen.*
- *Observer notes: Find filters right off the bat. Exclamations as the colors change.*
- *Mom: "You filtered it. What does that mean?"*
- *Boy: "Is this the sun?" Mom: "I think so." Boy: "Why is it blue?" Mom: "I dunno"*

SDO Panel and Screen users were interested in the fact that these are real images of the sun, and they found them to be beautiful or cool-looking, often responding to them with "ooooo!" People didn't seem to get quite as exercised about the SDO images as they did about manipulating the ferrofluid, however.

- *Boy: "That's amazing!" Dad: "That is one huge star"*
- *Dad: "That's the actual sun. That's pretty neat."*
- *"It's awesome"*

Galileo Stations

The three touch screens that make up the Galileo Stations had the least attractive power of the four interactive elements in the exhibition, but still were attended by well over half of the sample (58%). Those who did choose to attend the Galileo Stations made fairly thorough use of them: 41% used two, 28% used all three, and 45% completed and then watched animation(s). Some users, usually children, had difficulty getting the screens/programs to behave, but most of them quickly succeeded, often with the help of an adult.



Touch the Sun Exhibition – Summative Evaluation Report

Frequently, a child initiated time with the Galileo stations by scribbling on one of the screens; often an adult then joined the child, restarted the program, read and guided the child's interaction with it. Several parent-child groups used the Galileo Stations and watched the animations, sometimes working carefully together, other times with one person focused on the activity and the other (usually the child) coming and going during the process.

- *Observer notes: Boy drawing picture. Mom came over and restarted the station. She read the instructions aloud. Explained what the instructions meant. Counted sunspots with her son as they circled them. Having conversation while counting. Mom walking them through each of the slides. Went through all 6 slides. Watched animation.*
- *Observer notes: 1st time: Boy making pictures on screen. Keeps hitting the restart button with his arm and having to start over. Getting frustrated. 2nd time: Mom shows boy how to circle sunspots. Guided him through each screen. Boy lost interest on 3rd screen and left. 3rd time: Both boys scribbling across screen together. Showing parents their drawings. Repeats activity and sit down to watch animation. Boy watches mom use screen correctly. 4th time: Mom puts boy in her lap and they draw over the magnified sunspots together. Mom continually having to reengage him in activity. Conversation around what they are drawing, i.e. crazy hair, smelly foot. Boy brings Dad over to see their animation. Boy goes over to see brother's drawing.*
- *Observer notes: Mom and son use each of these very thoroughly. Sometimes watching each other. Tracing flares, etc. They make repeat visits to each one. Dad comes and goes, watches kid, then looking at SDO, goes there for pix and then returns to son at GS.*
- *Observer notes: Girl drawing at sunspots while Dad gives her instructions. Watch animation. ... Girl trades seat with Dad. She watches as he circles the sunspots. Girls scribbles on the other 2 screens then comes back to see Dad's animation.*

Adult pairs were also seen to make use of the Galileo Stations without children.

- *Observer notes: Each woman picked her own screen. Both read text before beginning. Both used correctly. Watched animations. Then moved to a different screen. Both women used all three screens but their visits got successively shorter with each screen they visited.*
- *Observer notes: Read opening screen before touching the screen at all. Woman circled sunspots and man pushed next button. Went through each of the screens quickly. Watched animation.*

Additional notes:

- Conditions limited how well observers could listen to Galileo Station user conversations.
- The email function was not available during data collection.



Tracking & Timing Sample Description

Group Size	Count	% (n=50)
1	2	4%
2	13	26%
3	20	40%
4	12	24%
5+	3	6%
Group Makeup	Count	% (n=50)
Adult(s) + Child(ren)	36	72%
Adults Only	6	12%
Adult Alone	2	4%
Adult(s) + Teen(s)	2	4%
Adult(s) + Teen(s) + Child(ren)	4	8%
Estimated ages of group members	Count	% (n=154)
8-12	60	39%
13-18	9	6%
19-25	15	10%
26-59	67	44%
60+	3	2%
Apparent gender of group members	Count	% (n=154)
Female	67	44%
Male	87	56%



Serrell's 51% Solution – Thorough Use of Exhibitions

Introduction

In her book, *Paying Attention: Visitors and Museum Exhibitions*, Beverly Serrell posits the 51% Solution analysis as a means of understanding summative evaluation findings. In this approach, for an exhibition to be considered thoroughly used and effective, evaluation findings must indicate that:

- At least 51% of visitors attend at least 51% of the elements in the exhibition.
- At least 51% of visitors move through the exhibition at a rate of 300 square feet per minute or less, and
- At least 51% of visitors can articulate the main message upon exiting the exhibition.

A tracking and timing study of visitors in the exhibition, and a self-completed exit survey provide data for analysis of these points. At the root of this approach is the understanding that people cannot learn from or consider things that they have not attended.¹ The details of this approach stem from hundreds of summative evaluation studies conducted by Serrell and her colleagues.

51% Solution Applied to *Touch the Sun*

When viewed through the lens of the 51% Solution analysis, as described below, impressive findings about dwell time, use of components, and perceived messages tell us that *Touch the Sun* is a very effective exhibition for casual visitors. Results of this analysis indicate that visitors are making thorough use of *Touch the Sun*, and easily recognizing and understanding key exhibition messages.

At least 51% of visitors attend at least 51% of the elements in the exhibition.

When considering the four interactive elements and the two murals, for a total of six exhibit components, we find a median of three elements attended. This does not quite reach 51% of the six components, or 3.06 components. When we drop the two murals and consider only the four interactive components, we find a much higher relative median of 2.96 elements attended. This surpasses 2.04 components, or 51% of four, which suggests thorough exhibit use per Serrell's analysis.

At least 51% of visitors move through the exhibition at a rate of 300 square feet per minute or less.

In *Touch the Sun*, an 1100 square foot exhibition, a "sweep rate" of 300 square feet per minute would require a dwell time of a little less than four minutes (3.66 minutes). Data in this study reveal a much longer median dwell time of six minutes, which makes for a sweep rate of 183.33 square feet per minute. This tells us that visitors move through the space even more slowly than Serrell's formula would require as an indicator of thorough use.

At least 51% of visitors can articulate the main message upon exiting the exhibition.

Overall, a large majority of survey participants struck on at least one of three main themes (75%). When asked about the main message or reason for *Touch the Sun*, survey respondents most often struck on the complex and dynamic nature of the sun, including how it works and specific features such as magnetism (54%). In smaller numbers they emphasized the exhibit as a way to see images of the sun that are not usually available (19%), and/or found a theme of the sun's relationship to Earth and humans (13%).

¹ Serrell, Beverly, *Paying Attention: Visitors and Museum Exhibitions*, American Association of Museums Technical Information Service, 1998, page 7



This Study

Research Questions

The primary purpose of this summative evaluation was to assess the impacts that attending the *Touch the Sun* exhibition has on casual visitors. In alignment with the National Science Foundation’s Framework for Evaluating Impacts of Informal Science Education Projects (NSF, 2008), the study focuses specifically on exhibit-related knowledge, engagement and attitude. A secondary purpose of this evaluation is to understand how thoroughly the exhibition is being used overall, as well as how individual components are used.

The “Big Idea” for *Touch the Sun* provided by staff provides the basis for evaluation data analysis.

The Sun is a dynamic and ever-changing object in space, and modern scientific observation of it reveals intricate details of its cycles of activity, giving us great insight into the many ways that the Sun's behavior affects the Earth.

The following evaluation questions guided this study:

1. To what extent do casual visitors to the *Touch the Sun* exhibition perceive intended messages as stated in the Big Idea?
2. What lessons do casual visitors take away from *Touch the Sun*?
3. How are the exhibition and individual components used by casual visitors?
4. What about the exhibition and/or which exhibit components generate excitement and awe in casual visitors?

Methods

Overview

The table below describes this two-pronged study which is typical of summative exhibit evaluations. The Tracking and Timing observational study, and the Exit Survey closely² follow the study design in Beverly Serrell’s book, *Paying Attention*.³ The following study design was submitted for IRB review and granted an exemption. Please see Appendix A for the exemption notice from Ethical & Independent Review Services.

Study	Description	Respondent Participation
Tracking & Timing	Unobtrusive observation of randomly selected visitors to record: <ul style="list-style-type: none"> • dwell time overall and at sun images station • elements attended, • behaviors including: manipulating interactives, reading labels, pointing out, discussing, laughing, calling others over, watching others engage with exhibits; sitting 	<ul style="list-style-type: none"> • Visitor is not approached or engaged. • Observations are to be unobtrusive, if a visitor appears as though they sense that they are being observed the data collector will stop that observation and leave the area for a brief time before staring another case • No identifying information will be recorded at any time

² One key difference between Serrell’s method and that used here, is that exit survey respondents were not cued in advance as prescribed in Serrell’s book.

³ Serrell, Beverly, *Paying Attention: Visitors and Museum Exhibitions*, American Association of Museums Technical Information Service, 1998



Touch the Sun Exhibition – Summative Evaluation Report

Study	Description	Respondent Participation
Exit Survey Self-completed Questionnaire	<ul style="list-style-type: none"> • Randomly selected adult visitors are invited to complete a survey upon exiting the exhibition area • The questionnaire is a short form with open-ended and fixed response questions including demographics 	<ul style="list-style-type: none"> • Participation is optional • Respondent can refuse to participate, refuse to answer any question, leave the survey at any time • No identifying information will be recorded at any time
Logistics	<ul style="list-style-type: none"> • Only one study will be conducted at a time • The small size of the exhibition area will limit us to one data collector at a time for this study • These studies are mono-lingual - English 	

Tracking & Timing Protocol

- Randomly select adult or youth visitor upon his/her entering the exhibition area
- Begin timing on stop watch; end timing when subject exits
- Record on exhibit map path visitor uses through the space
- Record what elements are attended to and what behaviors are expressed
- Behaviors recorded: stopping (>3 seconds); reading; watching; manipulating interactive components; discussing content with social group or strangers; calling people over; laughing; photographing; apparent excitement/engagement
- Demographics recorded: apparent age; apparent sex
- Other data recorded: dwell time, apparent number and makeup of social group (adult(s); youth; child(ren))
- Should an observation subject appear to become aware of the observation in progress, the data collector will end the observation and leave the area for a brief time before returning to begin another case.
- Should any visitor become curious and ask the data collector what they are doing, the data collector will explain that he/she is observing how the exhibit is being used.

Exit Survey Protocol

- Upon exiting the exhibit area, randomly selected adult visitors will be invited to complete a short questionnaire.
- Invitation script:
 - Hi, we’re collecting feedback about this exhibit from visitors today. Can you take a few minutes to fill out our questionnaire? This is completely optional. It takes most people about 4-5 minutes to complete.
 - Pause for reply: if no: ok, thanks anyway have a good visit; if yes: great, thanks!
 - Show visitor to seating and provide questionnaire and a pencil.
- Exit survey questions: See Appendix C



Recommendations

Summative evaluation studies of the *Touch the Sun* exhibition found it to be thoroughly used and well understood by most visitors. Though we did not use a remedial evaluation approach, a few refinements to the exhibition are suggested by questions that visitors have in response to exhibit components. The existing labels are being read by adults and evidence suggests that they are usually well understood, however a few questions came up repeatedly.

- Will touching the Plasma Globe hurt? Why doesn't it hurt to touch the Plasma Globe?
- Why is the sun blue/colorful? [SDO]
- What is this stuff? [ferrofluid]

Each of these questions offers a direct and natural access point to the component. That and the fact that children often initiate contact with the interactives before the adult member(s) of their social groups (particularly the Plasma Globe, Ferrofluid, and Galileo Stations) suggest creating a series of short, child-friendly labels rather than augmenting existing labels.

A series of short labels written, designed and positioned for children could address key points related to visitor questions at each interactive component. Below are suggestions for content (not exact wording).

- Plasma Globe
 - The plasma in this globe looks like the plasma that the sun is made of.
 - The plasma in this globe won't hurt you because ____.
 - Why doesn't this plasma hurt you? It looks like the plasma on the Sun, but it's not as hot.
- Ferrofluid Interactive
 - The black goo is made out of ____, which is magnetic.
 - Magnets make the black goo move, like the sun's magnetic fields make plasma move.
 - What is that black goo? That gooey stuff is ____, which is magnetic. The magnets under the table move it around the way that the sun's magnetic fields move the plasma.
- SDO Panel and Screen
 - If you could look at the sun it would look white or yellow. (Warning never to do this.)
 - The sun looks colorful in these videos because ____.
 - Why is the sun so many colors? Special camera filters show colors of light in the sun that the human eye can't see.
- Galileo Stations
 - Take a close look at the shapes that magnetic fields make in the Sun's plasma.
 - Draw an animation of them that you can email to yourself.



Appendix A – IRB Exemption Letter



March 4, 2013

Wendy Meluch, MA, BA, BA. Certif.
Visitor Studies Services
115 Trish Drive
Novato, CA 94947

RE: Touch the Sun

Using the exemption review process, the E&I administrative review team has accepted your study in accordance with 45 CFR 46.101(b)(2). Please keep this approval document with your study records.

- E&I is making a determination that the study qualifies for an exemption from the need for IRB review.
This determination does not include review of a consent process or form or of the research itself.
Researchers are advised that they should adopt the principles in The Belmont Report or an appropriate ethical code in the conduct of their studies.
Researchers are advised to maintain excellent communication with site/school authorities.
All researchers must comply with relevant state and federal regulations.

Table with 2 columns: Field and Value. Fields include E&I Assigned Study ID, Date of Certification, and Date of Check-In.

Minimum Responsibilities of the Research Team:

- 1. Report any protocol violations, and or serious and related unanticipated problems involving risks to your subjects or others in a timely manner.
2. Submit any desired modifications for review and consideration prior to carrying out such changes.
3. Submit an update of your study activities before the check-in date noted above.

Thank you for choosing E&I and please feel free to contact us anytime, we are here to help.

Sincerely,

Handwritten signature of Mona Bosch, CIP

Mona Bosch, CIP
E&I Administrative Review Team

cc: Benjamin Burrese, bburrese@chabotspace.org

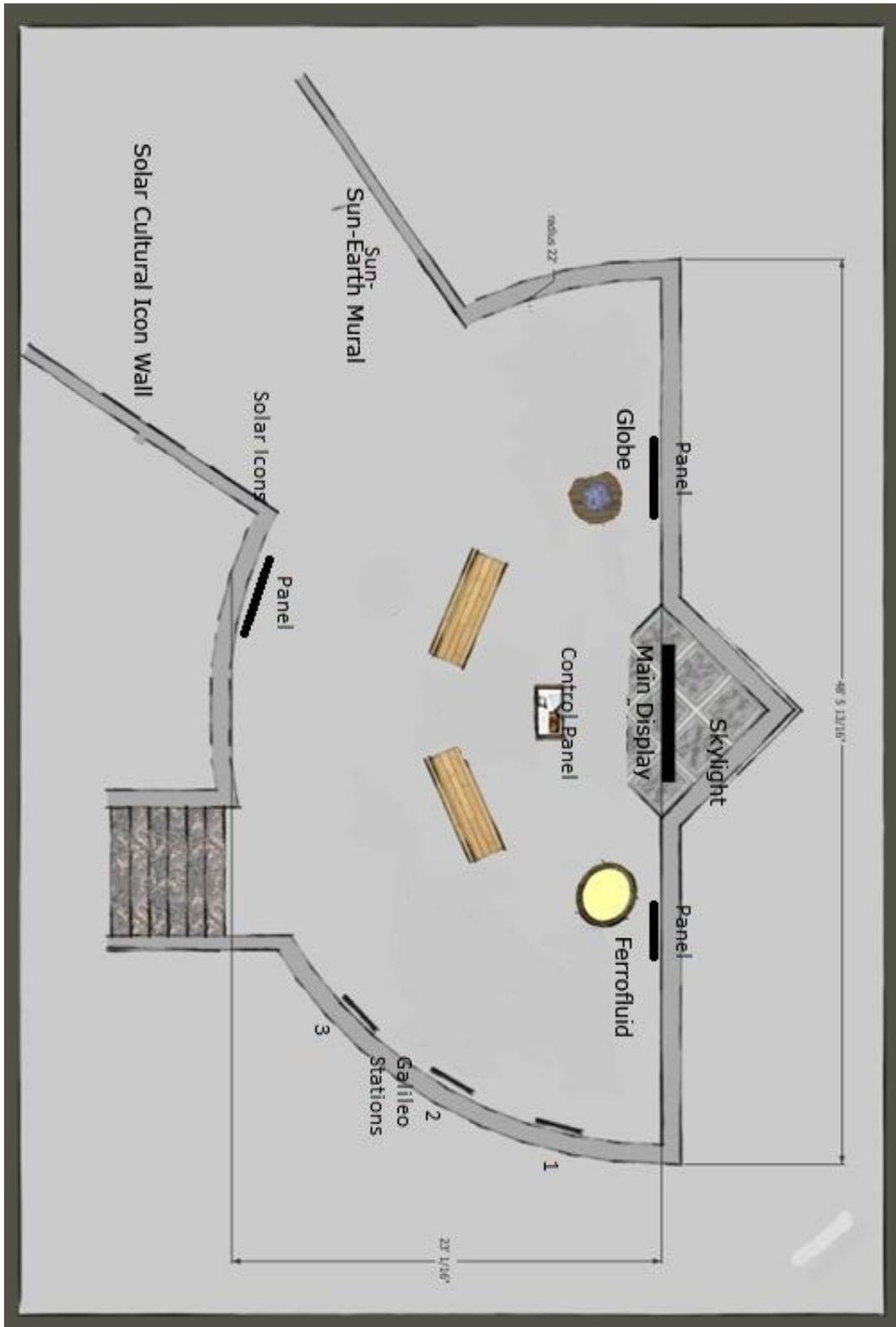
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Appendix B – Exhibit Map





Touch the Sun Exhibition – Summative Evaluation Report

Appendix C – Self-completed Exit Survey Form (adapted to fit this page)

Touch the Sun – Visitor Survey Chabot Space & Science Center

Thank you for participating in this research. Your participation is voluntary. Feedback from visitors like you will help us improve this exhibit. It takes most people about 4 or 5 minutes to complete this questionnaire form. Thank you!

1. Do you have any special interest, knowledge or training that you feel helped you better understand or appreciate the exhibits in this area? Yes No

If yes, please describe.
 2. What would you say is the main purpose of the *Touch the Sun* exhibition?
 - 2a. To show...
 - 2b. To make people...
 3. What is one new idea that you are taking away with you?
 - 3a. I didn't know, or I never realized that...

And/or
 - 3b. It reminded me that...
4. What part of the exhibit stands out for you the most? Why?
5. Did you send yourself an email from one of the drawing stations today? Yes No
6. Anything else?

Please tell us a little bit about yourself. (Circle your answers.)

7. How many are in your group today? 1 2 3 4 5 or more
8. Are you here... Alone / With adults / With children / With teens ?
(Circle all that apply.)
9. Your age? 8-12 13-18 19-25 26-59 60+
10. Your gender? Male Female

