Critical Angle
Post-Redesign Evaluation
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THIS IS A POST-REDESIGN EVALUATION REPORT

After an exhibit has been renovated, redesigned, or refurbished in preparation for the Exploratorium's move from the Palace of Fine Arts to Pier 15, an interview and observation study is conducted. The purpose of the study is to identify any major issues that would require immediate attention prior to the move. This collection of redesign evaluations will serve as a baseline of information for the Exploratorium's new exhibit set at Pier 15.

Post-redesign studies like this one **are conducted quickly,** which may mean:

- small sample sizes
- expedited analyses
- brief reports

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Study Goals

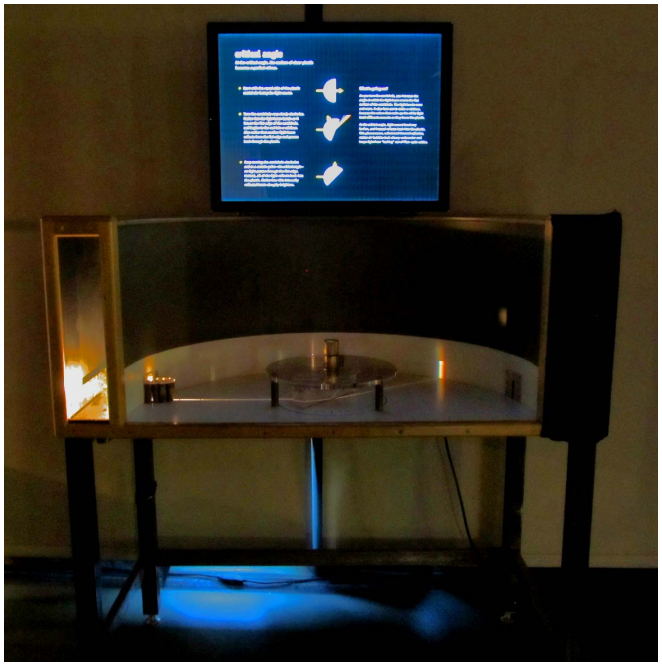
After an exhibit has been renovated, redesigned, or refurbished in preparation for the Exploratorium's move from the Palace of Fine Arts to Pier 15, an interview and observation study is conducted. The purpose of the study is to identify any major issues that would require immediate attention prior to the move. This collection of redesign evaluations will serve as a baseline of information for the Exploratorium's new exhibit set at Pier 15.

General goals:

- To confirm that visitors are able to access and use the exhibit
- To confirm that visitors can build a basic understanding of the exhibit's content
- To uncover visitors' frustrations and confusions
- To understand whether visitors move on from an exhibit for intrinsic or extrinsic reasons

Exhibit Description

When light passes from one transparent medium to another, some of it is reflected, while the rest is transmitted through the material. At the critical angle, the surface of clear plastic becomes a perfect mirror.



Methods

Uncued observations and interviews were conducted. A researcher randomly selected visitors who crossed an imaginary line on the floor that stopped facing the exhibit with two feet planted and either looked at or touched the exhibit for approximately 15 or more seconds.

Uncued visitors do not know they are part of the study until after they finish using the exhibit so their behavior can be considered representative of normal use patterns. This means that some of the visitors in this study may have used the exhibit only briefly.

Visitors were approached after they left the exhibit and asked if they would be willing to participate in a 7-question interview about their experience at the exhibit.

Demographics

Gender	Count (N=9)
M	6
F	3

ESL	Count (N=9)
N	6
Y	3

Estimated Age	Count (N=9)
8-12	0
13-17	1
18-29	1
30s	5
40s	2
50s	0
60+	0

Group Composition	Count (N=9)
Adults-only	6
Adults with children	3
Adults w/ teens	0
Adults w/ teens and children	0

Findings

Holding Time

This is the time the visitor spent using or otherwise engaged with this exhibit. The amount of time a visitor spends at an exhibit is influenced by many factors and can indicate level of engagement or interest, but not as a measure on its own.

Time at exhibit	(N=9) [mm:ss]
Mean	0:51
Median	0:45
Minimum	0:21
Maximum	2:13

Visitor Behaviors

Visitors were observed as they used various parts of the exhibit.

Started with flat side on right	Count (N=9)
Yes	3
No	1
Unsure	5

Turned clockwise	Count (N=9)
Yes	4
No	4
Unsure	1

Turned very slowly	Count (N=9)
Yes	7
No	2

Pressed blue button	Count (N=9)
No	3
Before main task	2
After main task	4

Visitor Interest

Visitors were asked about their interest in the exhibit and why they rated from "not interesting" to "very interesting" (1 – 7).

Interest level	Count (N=9)
High Interest (6-7)	1
Moderate Interest (4-5)	5
Low Interest (1-3)	3

Visitor responses:

H	Because I'm interested in light. The study of the visible light spectrum and how it ends. Tracking the reflection and the changes of the light in comparison to the shape of the glass.
M	Because I like the experiment, it's nice. The light effect.
M	Because I know what's going on, I don't have to read it, I can just see it.
M	Because colors and light, that interests me. At first I didn't see how it worked but then I got it.
M	I think that prisms and breaking light apart are really interesting. And it shows it really well... particle separation.
M	It's kinda interesting because it shows a really small area [of light] with both lights (the main light and the blue button light) and that's not what you expect. They both do the same thing.
L	I didn't understand what's going on.
L	Compared to everything else, not as interesting. The directions were hard to understand.
L	Because I wasn't able to figure out the purpose.

Visitor Frustration or Confusion

Visitors were asked to tell us if there was anything confusing or frustrating, what the source of the frustration was, and whether or not it made them want to leave the exhibit and move on to another one.

Source of visitor frustration or confusion*	Count	# that wanted to move on
Unlabeled blue button/light	3	3
Couldn't focus	1	0
Didn't understand	1	0
Confusing label	1	0
Response unclear	1	0
Nothing frustrating	5	--

*Totals may add up to more than N = 9 because visitors gave more than one response.

Visitor Understanding

Visitors were asked what they think the exhibit was about with the goal to determine whether or not they have a basic understanding of the concepts presented and to identify possible areas of misunderstanding. We acknowledge that this study has a small sample size and that these findings illustrate trends and may not be representative.

It appears that visitors DO have a basic understanding of concepts presented.	X
It appears that visitors DO NOT have a basic understanding of concepts presented.	

Visitor responses:

- It's a prism, and we have both reflection and refraction. Just [by] changing the angle.
- It's about the angle at which the light is being reflected. At the point where it is getting, what is the English, well, bent. (Anything else?) No, that's it.
- I think it's about different objects and how they pick up colors and how our eyes perceive them.
- Something to do with lights and lenses…(reading label) Where did I read that it's a lens? (Anything else?) Something about prisms.
- The diffusion of white light through plastic
- When light bends and there's a critical angle where it bounces back.
- Bending light. [Anything else?] That's it.
- That's a hard one. I don't really know. (friend jumps in & says: See here it's an obtuse angle and that's an acute angle. So it's about the angle.)
- Changing the light from going straight by moving the circle. Changing the position on the wall.

Visitor Reasoning for Leaving the Exhibit

The goal of this question is to explore how open or closed-ended the exhibit seems to be for the visitor. Visitors tend to leave exhibits for intrinsic reasons, such as feeling bored, or finished with the experience, or for extrinsic reasons, like having to go to lunch or being distracted by another exhibit. Leaving for intrinsic reasons could suggest a more close-ended exhibit experience.

Reasons for moving on to the next exhibit	N=9
Intrinsic	8
Both	1
Extrinsic	0

Visitor responses:

Intrinsic	Not much to see. You can spend 5 seconds and then, "Next, please."
Intrinsic	When I went through all the steps and got to the point of what it was supposed to do.
Intrinsic	Most of the exhibits here have this magical feel of the science behind it, and this one didn't.
Intrinsic	I learned everything it had to show.
Intrinsic	I felt I learned everything I could from it.
Intrinsic	Less impactful than other exhibits. (Other girl: It doesn't have the wow factor.) (What does have the wow factor, for example?) Like the dowel thing with 2 people talking. A surprise.
Intrinsic	With me, probably when I realized I was done experimenting with it.
Intrinsic	I was not interested in reading any further.
Both	When you find out and try everything. [Anything else?] And we don't have much time to see everything [here at the museum].

Conclusions

Based on this small sample, we conclude that the redesigned exhibit does not require immediate remediation. This evaluation did not identify sufficient impediments to visitor use, engagement or basic understanding.

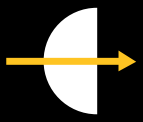
APPENDIX: Graphic Panel

6976_L1_CriticalAngle_MainLbl (24" x 18") NO round corners Backlit Film

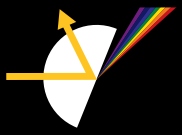
critical angle

At the critical angle, the surface of clear plastic becomes a perfect mirror.

- Start with the round side of the plastic semicircle facing the light source.



- Turn the semicircle *very slowly* clockwise. Notice that the light beam bends as it leaves the flat edge of the semicircle, and begins to fan out into a rainbow. Also notice that another light beam reflects from the flat edge and passes back through the plastic.



- Keep turning the semicircle clockwise and at a certain point—*the critical angle*—no light passes through the flat edge. Instead, all of the light reflects back into the plastic. Notice how this internally reflected beam abruptly brightens.

What's going on?

As you turn the semicircle, you increase the angle at which the light beam meets the flat surface of the semicircle. The light bends more and more. It also fans out to make a rainbow, because the colors that make up the white light bend different amounts as they leave the plastic.

At the critical angle, light cannot bend any farther, and instead reflects back into the plastic. This phenomenon, called *total internal reflection*, makes air bubbles look silvery underwater and keeps light from "leaking" out of fiber optic cables.

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