Visualizing The Bay

EVALUATION REPORT

Exploratorium June 2015

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PHOTO http://www.exploratorium.edu/visit/bay-observatory-gallery/visualizing-the-bay
THIS IS NOT a definitive final report

FORMATIVE evaluation studies like this one often:

• **are conducted quickly**, which may mean
  o small sample sizes
  o Expedited analyses
  o Brief reports

• **look at an earlier version** of the exhibit/program, which may mean
  o a focus on problems and solutions, rather than successes
  o a change in form or title of the final exhibit/program
Visualizing The Bay “is an exhibit platform consisting of a three-dimensional topographical relief map of the San Francisco Bay Area and a projection system that displays interactive digital visualizations featuring different aspects of the Bay Area landscape” (Ma, 2012). At the time of this observation study, visitors at Visualizing The Bay could select from among four visualizations: Overview, Fog Browser, Finding Fault Lines, and Who Lives Where? A control panel consisting of touch screen soft buttons and a scroll dial allowed visitors to control each interactive visualization.

Study Purpose:
This study sought to learn about visitors’ use of a touch screen and scroll dial control panel to explore four different visualizations (comparing to a prior version with 3 visualizations available at a time and a hard button and scroll dial control panel). Further, this study explored the effects of changes made to the Overview (2013=Orientation) visualization.

Methods: Video data were collected on the afternoon and evening of May 7th, and throughout the day on May 10th, a free day.¹ We randomly selected the 3rd visitor² who looked age 8 or over, and coded behavior and conversations at the exhibit. 69 interactions were coded.

*This evaluation draws heavily from, and builds upon, the prior evaluation conducted by Joyce Ma (2013).

<table>
<thead>
<tr>
<th>Visualization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>a slideshow survey of the invisible dynamics of the Bay Area with data from various sources. At the time of this evaluation, visitors could control the sequence but not the speed of the datasets featured in the slideshow.</td>
</tr>
<tr>
<td>Finding Fault Lines</td>
<td>the location of every earthquake since 1973 and the major and minor faults in the Bay Area, from the US Geological Survey. Visitors could scroll through time to see the location and magnitude of each quake. A toggle button revealed or hides the fault lines.</td>
</tr>
<tr>
<td>Fog Browser</td>
<td>a simulation of the fog pattern in the Bay Area based on a NOAA model. Visitors could scroll through a 24-hour period to look at changing patterns. They could use a button to look at the modeled fog data either for the past day or for a typical day in summer.</td>
</tr>
<tr>
<td>Who Lives Where</td>
<td>data showing the Bay Area population by age and by race and ethnicity, according to self-reports and the 2010 US Census. Visitors could use the button to switch between age and race/ethnicity and then use the scroll knob to look at the different subgroups. The visualization is the work of Eric Fisher.</td>
</tr>
</tbody>
</table>

¹ video data from May 9th were not used because one of the visualizations was not working
² When very slow, such as on May 7th, we reduced to every 2nd visitor
3
Summary of key findings:

- Shifting from three to **four visualizations** led to
  - NEARLY 1/3 USING ALL 4 (30% of visitors used all 4 visualization, yet 36% used only 1)
  - INCREASED time spent at the model (up to 2 minutes and 20 seconds on average)
  - DECREASED percentage of time spent at the model using each visualization

- Shifting to **soft buttons and a scroll dial** (rather than hard buttons and a scroll dial) led to
  - NO major differences in how people physically interact with the model and controls
  - NO major differences in how people explore the data sets
  - INCREASED interactions with others (however, this increase may be due to video coder differences)
  - THE MAJORITY OF VISITORS NOT PRESSING SOFT BUTTONS
  - FAR FEWER FEMALES USING CONTROLS. The team is using prior research about better engaging females to adjust the look/feel of the soft button screens, and perhaps the control design
  - CONFUSION ABOUT ALREADY PRESSED BUTTONS. A quarter (25%) of visitors tried pressing a button that was already selected. The team is redesigning the look to address this issue
  - SCROLL SPEED: Needs to be optimized for each visualization
  - AUTO CHANGE: The slides automatically change if no buttons have been pressed in a window of time. The team is expanding this window of time to 5-6 minutes

- Changing the title of the initial visualization from Orientation to **Overview** resulted in
  - INCREASED use of the visualization (up 25%)
  - DECREASED use of the Finding Fault Lines (down 29%) and Fog Browser (down 22%) visualizations
  - SPREADING use of the model more evenly across all four visualizations is considered a positive outcome by the team

- Giving visitors **control over the Overview slide show, and improving the look of these slides along with adding landmarks**, all in an attempt to improve time spent in this visualization
  - DID NOT INCREASE time spent in the Overview visualization
  - DID NOT CHANGE the finding that people spent the LEAST amount of time in the Overview Viz
INFORMATION ABOUT THE STUDY PARTICIPANTS
http://www.exploratorium.edu/visit/bay-observatory-gallery/visualizing-the-bay

http://thisfineday.com/blog/2013/6/25/exploring-the-new-exploratorium

**Demographics:**
- **83% Adult**
- **17% Child/Teen**
- **54% Female**
- **46% Male**
STUDY FINDINGS: OVERALL MODEL
NUMBER OF VISUALIZATIONS USED (PERCENTAGE OF VISITORS):

Average number of visualizations used = 2.4 (between 2 and 3).

http://www.exploratorium.edu/visit/bay-observatory-gallery/visualizing-the-bay
TIME SPENT AT THE MODEL

Average time spent: 2 minutes and 20 seconds
Median time spent: 1 minute and 34 seconds

This is up from average of 1 minute and 52 seconds in the 2013 evaluation when only 3 visualizations were available to each visitor.

https://www.behance.net/gallery/11364633/Exploratorium-Exhibits Michael S
PHYSICAL INTERACTION WITH THE MODEL

Of note, Females were much less likely to:
- Use the controls (35%f & 56%m; p = .08), and
- Use the scroll (22%f & 56%m; p = .003)
VISITORS’ EXPLORATIONS OF DATA SETS

- 74% Didn’t find a location on map
- 26% Found location on map
- 90% Didn’t search for particular datum on the map
- 10% Did...
- 24% yes w/ 3 viz & hard buttons
- 18% yes w/ 3 viz & hard buttons
- 7% Did...
- 90% Didn’t make comparisons
- N/A
VISITORS’ INTERACTION WITH OTHERS

- 78% Spoke about the content and/or experience
- 88% Collaborated/interacted with others
- 22% Didn’t...

http://www.exploratorium.edu/visit/bay-observatory-gallery/visualizing-the-bay
STUDY FINDINGS: PER VISUALIZATION
**COMPARING VISITORS’ USE ACROSS VISUALIZATIONS**

<table>
<thead>
<tr>
<th>Visualization</th>
<th>% of visitors SAW/USED the visualization (2013 evaluation results)</th>
<th>% of visitors PHYSICALLY CHOSE the visualization themselves (no 2013 equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview (Orientation in 2013)</td>
<td>64% (44/69)</td>
<td>32% (14/44) chose it themselves</td>
</tr>
<tr>
<td>Finding Fault</td>
<td>67% (46/69)</td>
<td>33% (15/46) chose it themselves</td>
</tr>
<tr>
<td>Fog Browser</td>
<td>49% (34/69)</td>
<td>41% (14/34) selected it themselves</td>
</tr>
<tr>
<td>Who Lives Where</td>
<td>61% (42/69)</td>
<td>19% (8/42) selected it themselves</td>
</tr>
</tbody>
</table>

*Use of the Overview Visualization increased quite a lot (by 25%)*

*However, use of the Fault & Fog Visualizations decreased quite a lot (by 29% & 22%)*

**COMPARING VISITORS’ DWELL TIME ACROSS VISUALIZATIONS**

<table>
<thead>
<tr>
<th>Visualization</th>
<th>Average holding time (2013 evaluation results)</th>
<th>Median holding time (halfway point) (2013 evaluation results)</th>
<th>Mean % time spent at visualization out of total time (2013 evaluation results)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview (Orientation in 2013)</td>
<td>34 secs (35 secs)</td>
<td>34 secs (14 secs)</td>
<td>21%</td>
</tr>
<tr>
<td>Finding Fault Lines</td>
<td>1 min 25 secs (1 min 15 secs)</td>
<td>51 secs (42 secs)</td>
<td>49%</td>
</tr>
<tr>
<td>Fog Browser</td>
<td>46 secs (49 secs)</td>
<td>26 secs (36 secs)</td>
<td>25%</td>
</tr>
<tr>
<td>Who Lives Where</td>
<td>59 secs (1 min 15 secs)</td>
<td>27 secs (42 secs)</td>
<td>36%</td>
</tr>
<tr>
<td>Total</td>
<td>2 mins 20 secs (112 secs)</td>
<td>1 min 34 secs (71 secs)</td>
<td></td>
</tr>
</tbody>
</table>

*Visitors still spend the least amount of time in the Overview viz*

*Visitors spent a lower % of total time at each of the visualizations, which is expected given the added fourth visualization*
BAY AREA OVERVIEW

VISUALIZING THE BAY AREA
Discover some of the natural and human processes that shape the regional landscape.

<table>
<thead>
<tr>
<th>BAY AREA OVERVIEW</th>
<th>Identifying populated areas, terrain, and transportation routes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINDING FAULT LINES</td>
<td>You Are Here, Transportation</td>
</tr>
<tr>
<td>FOG BROWSER</td>
<td>Population, Summits, Elevation, and Depth</td>
</tr>
<tr>
<td>WHO LIVES WHERE?</td>
<td></td>
</tr>
</tbody>
</table>

- **% SAW/USED**: 64%
  - 39% w/ 3 viz

- **AVG TIME**
  - 34 SECS
  - 35s w/ 3 viz

- **AVG % HOLDING TIME SPENT**
  - 34%
  - 24% w/ 3 viz

- **# of the 4 SOFT BUTTONS PUSHED**
  - *66% did not press any*
  - *27% pressed 2+*
  - *11% pressed 4+*
FINDING FAULT LINES

VISUALIZING THE BAY AREA
Discover some of the natural and human processes that shape the regional landscape.

The location of every earthquake in the Bay Area since 1973.

% SAW/USED
67%

AVG TIME
1 MIN
25 SECS

AVG %
HOLDING
TIME SPENT
50%

# of the
2 SOFT
BUTTONS PUSHED

*74% did not press any
*26% pressed 1+
*13% pressed 2+

Use dial to scroll through time
FOG BROWSER

VISUALIZING THE BAY AREA
Discover some of the natural and human processes that shape the regional landscape.

The formation and movement of fog across the Bay Area.

Use dial to scroll through time

% SAW/USED
49%
71% w/ 3 viz

AVG TIME
46 SECS
49s w/ 3 viz

AVG % HOLDING TIME SPENT
31%
51% w/ 3 viz

# of the 2 SOFT BUTTONS PUSHED
*74% did not press any
*26% pressed 1+
*1% pressed 2+
WHO LIVES WHERE?

Census data showing Bay Area population by age and by race and ethnicity.

% SAW/USED
61 %
67% w/ 3 viz

AVG TIME
59 SECS
1m 15 s w/ 3 viz

AVG % HOLDING TIME SPENT
45 %
62% w/ 3 viz

# of the 11 SOFT BUTTONS PUSHED

*83% did not press any
*17% pressed 1+
*12% pressed 7+
ISSUES AND NEXT STEPS
BIGGER ISSUES

CONFUSION ABOUT ALREADY PRESSED BUTTON This is the biggest issue with the soft buttons. A quarter (25%) of visitors tried pressing a button that was already selected. Most (59%) did it more than once (up to 8 times), while 41% did it only once.

NEXT STEPS: The team has adjusted the look of each visualization soft button page, simplifying the color scheme on each page and therefore using color solely to highlight whether a button is depressed.

ISSUES WITH THE SCROLL DIAL 3 visitors pushed the scroll dial, and 2 visitors were frustrated that the scroll was too slow (1 at Fault and 1 at Fog).

NEXT STEPS: The team is considering potential approaches to reducing scroll dial pushes, and will adjust the dial speed to optimize per visualization.

ISSUES WITH AUTO CHANGE 2 visitors experienced an automatic change while they were exploring Overview Visualization.

NEXT STEPS: The slides go into auto-change mode after a certain amount of time passes with no button pressing so that the model does not sit idle when it is not being used. The team is expanding this window of time to five minutes, or the max time spent in any visualization (6 minutes).

FAR FEWER FEMALES USING CONTROLS

NEXT STEPS: The team is using prior research about better engaging females (e.g., incorporating a female designers and adjusting aesthetics) to alter the look and feel of the soft button screens, and considering changes to the control panel design, and additions of more female-friendly content.

BUGS

All software bugs were highlighted for the multimedia team.

NEXT STEPS: The multimedia team has addressed each bug.
SMALLER ISSUES

CONFUSION ABOUT PRESENTATION OF DATA
In VIZ Who Lives, at least two visitors commented on the 'multi-racial' statistical representation not making sense/ not seeming accurate. A visitor also noted that using different sized dots of same/similar color to represent number of residents on the map made it all blur together, rendering it difficult to discern population numbers (they felt colors would help).

NEXT STEPS: The team will run this by the visualizations’ scientist, Eric Fisher, to determine next steps.

ISSUES WITH MULTIPLE USERS
Only 2 instances where multiple children interfered by using the buttons and scroll dial simultaneously. This seems more like family dynamics that an issue with affordances.

NO ACTION NECESSARY.

CONFUSION ABOUT SEQUENCING OF VISUALIZATIONS
This does not seem to be an issue. The only evidence that any visitors considered sequencing were: 2 visitors reset the Bay Model to Overview when they were finished. One of them insisted that their child stop randomly manipulating buttons and cycle through them ‘in order.’

NO ACTION NECESSARY.
PUSHING THE SCROLL LANGUAGE ARROW

FIXED
BY
REMOVING
THE ARROW
AND BETTER
ALIGNING THE
TEXT WITH THE
SCROLL DIAL
PLACEMENT OF THE CONTROL PANEL

We tried placing controls off to the side under the map text, but found people stayed at the controls when it was centered.
Summary Tables & Tests of Significance
### USE AND DWELL TIME BY GENDER & AGE

<table>
<thead>
<tr>
<th></th>
<th>Count (% all visitors)</th>
<th>Mean holding time</th>
<th>Median holding time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>37 (54%)</td>
<td>2 mins 24 secs</td>
<td>1 min 34 secs</td>
</tr>
<tr>
<td>Male</td>
<td>32 (46%)</td>
<td>2 mins 14 secs</td>
<td>1 min 35 secs</td>
</tr>
<tr>
<td>Adult</td>
<td>57 (83%)</td>
<td>2 mins 29 secs</td>
<td>1 min 47 secs</td>
</tr>
<tr>
<td>Child/Teen</td>
<td>12 (17%)</td>
<td>1 min 33 secs</td>
<td>1 min 16 secs</td>
</tr>
<tr>
<td>Everyone</td>
<td>69 (100%)</td>
<td>2 mins 20 secs</td>
<td>1 min 34 secs</td>
</tr>
</tbody>
</table>

### PHYSICAL INTERACTION BY GENDER & AGE

Percent of visitors who ...

<table>
<thead>
<tr>
<th></th>
<th>Touched the model</th>
<th>Used the controls</th>
<th>Used the scroll</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>35%</td>
<td>35%</td>
<td>22%</td>
</tr>
<tr>
<td>Male</td>
<td>47%</td>
<td>56%</td>
<td>56%</td>
</tr>
<tr>
<td>Adult</td>
<td>35%</td>
<td>44%</td>
<td>35%</td>
</tr>
<tr>
<td>Child /Teen</td>
<td>67%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Everyone</td>
<td>41%</td>
<td>45%</td>
<td>38%</td>
</tr>
</tbody>
</table>

### EXPLORATIONS OF THE DATA BY GENDER & AGE

Percent Visitors who...

<table>
<thead>
<tr>
<th></th>
<th>Found location on the map</th>
<th>Searched for a particular datum</th>
<th>Made comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>30%</td>
<td>3%</td>
<td>8%</td>
</tr>
<tr>
<td>Males</td>
<td>22%</td>
<td>19%</td>
<td>6%</td>
</tr>
<tr>
<td>Adult</td>
<td>26%</td>
<td>11%</td>
<td>7%</td>
</tr>
<tr>
<td>Child/Teen</td>
<td>25%</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Any Visualization</td>
<td>26% (24%)</td>
<td>10% (18%)</td>
<td>7% (no prior)</td>
</tr>
</tbody>
</table>
SOCIAL INTERACTION BY GENDER & AGE
Percent Visitors who…

<table>
<thead>
<tr>
<th>Gender</th>
<th>Talk content or experience</th>
<th>Collaborate with others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>78%</td>
<td>84%</td>
</tr>
<tr>
<td>Male</td>
<td>78%</td>
<td>94%</td>
</tr>
<tr>
<td>Adult</td>
<td>79%</td>
<td>89%</td>
</tr>
<tr>
<td>Child /Teen</td>
<td>75%</td>
<td>92%</td>
</tr>
<tr>
<td>Everyone</td>
<td>78%</td>
<td>88%</td>
</tr>
</tbody>
</table>

TESTS OF SIGNIFICANCE (* if significant at the .10 level):
Females were not significantly less likely to Touch The Model: Females (35%) than in Males (47%), $X^2_{(68)} = 0.98$, $p = .32$.
Females were significantly less likely to Use Controls at the .10 level, but not at the .05 level: Females (35%) than in Males (56%), $X^2_{(68)} = 3.09$, $p = .08^*$.  
Females were significantly less likely to Use Scroll Dial: Females (22%) than in Males (56%), $X^2_{(68)} = 8.76$, $p = .003^*$.

Visitors were not significantly more likely to Touch The Model in 2015 (41%) than in 2013 (31%), $X^2_{(366)} = 2.40$, $p = .12$.
Visitors were not significantly less likely to Use The Controls in 2015 (45%) than in 2013 (50%), $X^2_{(366)} = 0.58$, $p = .45$.
Visitors were not significantly more likely to Find Location On Map in 2015 (26%) than 2013 (24%), $X^2_{(366)} = 0.11$, $p = .74$.
Visitors were not significantly less likely to Search For Data in 2015 (10%) than in 2013 (18%), $X^2_{(366)} = 2.57$, $p = .11$.

Because we did not have an original coding scheme and the codes may be the reason for any differences:
We did not run statistics on visitors’ likelihood to Talk Content/Experience in 2015 (78%) compared to 2013 (60%).  
We did not run statistics on visitors’ likelihood to Collaborate/Interact With Others in 2015 (88%) compared to 2013 (67%).
CITATIONS

The 2013 version of the Bay Model

https://www.behance.net/gallery/1364623/Exploratorium-Exhibits

ACKNOWLEDGEMENTS
I would like to thank Adam Klinger for his help in collecting the video data, and Sarah Tsalbins for her thoughtful coding of the data in this study. I would also like to thank Joyce Ma for creating a template for evaluating this exhibit and for her generosity regarding our referencing of her prior work.

The team would also like to thank the Gordon and Betty Moore Foundation, who funded this work in part.