Pulley Table

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THIS IS NOT A DEFINITIVE FINAL REPORT

FORMATIVE evaluation studies like this one often:

- **are conducted quickly**, which may mean
  - small sample sizes
  - expedited analyses
  - brief reports

- **look at an earlier version** of the exhibit/program, which may mean
  - a focus on problems and solutions, rather than successes
  - a change in form or title of the final exhibit/program
Goals

The goal of this evaluation was to determine how long visitors spend at the current version of the exhibit, how they use the exhibit, and how the labels’ impact visitor use. In addition, we compare the current version of the exhibit (Version 3) to its initial version (Version 1).

Specifically, the evaluation assesses and compares across versions:

- visitor group holding time
- the number of “mission objects” (motor, fans, etc.) visitor groups use
- the number of times visitor groups make a change to a pulley system
- the number of “stations” (mini-table-tops) visitor groups use and whether they ever connect pulleys across stations

Summary of findings

This exhibit appears to engage visitors for extended periods of time in ways that indicate the attributes of APE. Specifically comparing Version 1 to Version 3, significantly more visitor groups in Version 3:

- spent extended amounts of time at the exhibit
- used one of the “mission objects”
- used the exhibit when other visitor group(s) were present

There was no difference across versions in how many visitor groups made a change to a pulley system.

The labels had little effect on the variables we measured; however, more visitor groups in the label condition used the music box than in the no-label condition.
Methods

We compared two versions of the exhibit, Versions 1 and 3. Both versions used similar pulleys and belts, however the tables were quite different and Version 3 had additional “mission objects” – objects designed to give visitors a goal in their construction of pulley systems.

Version 1 was comprised of two stations (mini-table-tops). The only mission object was a motor that constantly turned a pulley wheel. Version 3 consisted of four stations in a “Z” configuration. Each station contained a mission object: Motor (just like Version 1), Music Box, Twirling Umbrella, and Fan Assembly.

Table 1 shows photographs of the two versions of the exhibit.

**Table 1. Two versions of exhibit tested in this study**

<table>
<thead>
<tr>
<th>Version 1</th>
<th>Version 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Version 1" /></td>
<td><img src="image2.jpg" alt="Version 3" /></td>
</tr>
</tbody>
</table>

Visitor groups were recorded on audio/videotape as they used the exhibit. Table 2 shows the number of groups recorded using each version, as well as differences across version. The tapes were then coded for holding time and various visitor behaviors.

**Table 2. Number of Groups**

<table>
<thead>
<tr>
<th>Version</th>
<th>Tape Date</th>
<th>Groups</th>
<th>Stations</th>
<th>Missions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/2/03</td>
<td>45</td>
<td>2</td>
<td>√ Motor</td>
</tr>
<tr>
<td>3</td>
<td>12/14/03</td>
<td>59</td>
<td>4</td>
<td>√ Music</td>
</tr>
</tbody>
</table>
Visitors were also interviewed as they left the exhibit. Unfortunately, the interview data are not available at this time. However, a later draft of this report will include them.

**Results – holding time**

Visitor holding time across versions

Visitor groups spent more time at the exhibit in Version 3 than in Version 1. Table 3 shows the results for the holding time. An Analysis of Variance found that the log of the holding time for visitors significantly increased from Version 1 to Version 3 ($F_{1,102} = 9.44, \ p = .003$). (The log of the time is used because holding times are not normally distributed, but the logs of the times are distributed normally.)

**Table 3.** Holding time data

<table>
<thead>
<tr>
<th></th>
<th>Version 1 (min:sec)</th>
<th>Version 3 (min:sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>1:19</td>
<td>3:02</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>1:44</td>
<td>3:46</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>9:41</td>
<td>15:39</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>0:39</td>
<td>1:30</td>
</tr>
</tbody>
</table>
See Figure 1 for holding time distributions for both versions.

Figure 1. Holding time distributions for Versions 1 and 3.

Figure 2 shows the same holding time data, plotted as a “survival” graph: The percent of visitors remaining at the exhibit is shown for each time interval. The data from Version 3 indicate a marked shift to the right.
Figure 2. Survival time distributions for Versions 1 and 3.

Results – Exhibit usage

Manipulating pulleys and mission objects

Differences across versions

There were no differences across version in the percentage of visitor groups that used the motor. There were also no differences in the percentage that connected pulleys across stations. However, significantly more visitor groups in Version 3 used any mission object than groups in Version 1 ($\chi^2 = 22.9, p < .0001$). Table 4 shows the percentage of groups using each “mission object” and making cross-station connections.
Table 4. Visitors groups using mission objects and multiple stations

<table>
<thead>
<tr>
<th>Group Behavior</th>
<th>Version 1 (N=45)</th>
<th>Version 3 (N=59)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used Motor</td>
<td>56%</td>
<td>53%</td>
</tr>
<tr>
<td>Used Music Box</td>
<td>N/A</td>
<td>68%</td>
</tr>
<tr>
<td>Used Umbrella</td>
<td>N/A</td>
<td>76%</td>
</tr>
<tr>
<td>Used Fans</td>
<td>N/A</td>
<td>71%</td>
</tr>
<tr>
<td><strong>Used any mission object</strong></td>
<td><strong>56%</strong></td>
<td><strong>95%</strong></td>
</tr>
<tr>
<td>Connected 2 stations</td>
<td>22%</td>
<td>8%</td>
</tr>
<tr>
<td>Connected 3 stations</td>
<td>N/A</td>
<td>12%</td>
</tr>
<tr>
<td>Connected 4 stations</td>
<td>N/A</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Results in **bold** are statistically significant at the .0001 level.

We also assessed how visitor groups made changes to pulley systems at the exhibit. Specifically, we observed whether each group (a) moved a pulley wheel, (b) added / removed a belt or (c) both. We found no significant differences across versions. Table 5 shows the percentage of visitor groups in each version performing each action.

Table 5. Visitors groups using mission objects and multiple stations

<table>
<thead>
<tr>
<th>Group Behavior</th>
<th>Version 1 (N=45)</th>
<th>Version 3 (N=59)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moved pulley wheel</td>
<td>9%</td>
<td>3%</td>
</tr>
<tr>
<td>Added/removed a belt</td>
<td>13%</td>
<td>10%</td>
</tr>
<tr>
<td>Both</td>
<td>30%</td>
<td>42%</td>
</tr>
<tr>
<td>Total making a change</td>
<td>52%</td>
<td>55%</td>
</tr>
</tbody>
</table>

Differences across label treatments

Significantly more visitor groups used the Music Box in the Label condition compared with the No-Label condition. There were no other significant differences between the label conditions. See Table 6.

Table 6. Visitors groups using mission objects and multiple stations

<table>
<thead>
<tr>
<th>Group Behavior</th>
<th>Main label with 4 Experiment cards (N=27)</th>
<th>No Label (N=32)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used Motor</td>
<td>56%</td>
<td>50%</td>
<td>.67</td>
</tr>
<tr>
<td><strong>Used Music Box</strong></td>
<td><strong>81%</strong></td>
<td><strong>56%</strong></td>
<td><strong>.04</strong></td>
</tr>
<tr>
<td>Used Umbrella</td>
<td>70%</td>
<td>81%</td>
<td>.33</td>
</tr>
<tr>
<td>Used Fans</td>
<td>78%</td>
<td>66%</td>
<td>.30</td>
</tr>
<tr>
<td>Used any mission object</td>
<td>96%</td>
<td>94%</td>
<td>.66</td>
</tr>
<tr>
<td>Connected multiple stations</td>
<td>15%</td>
<td>25%</td>
<td>.33</td>
</tr>
</tbody>
</table>
There were no differences due to label in the fraction of visitor groups making changes to the pulleys systems (moving pulley wheels or adding / removing belts).

**Multi-group usage across versions**

We found that in Version 3, a significantly larger fraction of visitor groups used the exhibit while another visitor group(s) was present than in Version 1 ($\chi^2 = 10.8, p = .001$).

<table>
<thead>
<tr>
<th>Presence of other group(s)</th>
<th>Version 1 (N=45)</th>
<th>Version 3 (N=59)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other groups present</td>
<td>53%</td>
<td>83%</td>
</tr>
<tr>
<td>No other groups present</td>
<td>47%</td>
<td>17%</td>
</tr>
</tbody>
</table>

The label treatment had no significant effect on whether visitor groups used the exhibit alone or when other groups were present.

**Results – Exit Interviews**

We interviewed 9 visitors as they left the exhibit in Version 3. The interview consisted of 4 questions. The results are reported below.

**Question 1a: How engaging was this exhibit for you? Can you say why you chose that response?**

The multiple-choice responses are shown in Figure 3 below.
Figure 3. Responses to “How Engaging?” question in Version 3 exit interview.

Question 1b. Can you explain why you felt the exhibit was ___ engaging?

Very Engaging
Because you think and think and think and think....and you get it to work. You can learn something that leads to a serious discovery. You can get cooled off without using your energy (by using the fans)
I don’t know. (mom says, “Amanda, what did you tell me?”) it was playing music.

Engaging
Different things to move around. Things to modify. Change things and see the effect. (friends’ answers, “choices”)
Because they made gadgets to work on stuff. Stuff made out of anything, then can make something.
**Somewhat engaging**

Strings do not have enough tension. The kids spent some time. Need more rotary things. To tie one up to another, you need more chains.

I like mechanical stuff. I wasn’t sure what it was supposed to do. I didn’t read the instructions. I guess that is typical.

It was interactive. It was moving (meaning that it has parts that move). I don’t know....(laughs)

Initially it was a challenge, curious. It was frustrating to try and get the fans to go I wanted to try and make the fans spin. After I did, that was enough.

**Question 2. Was there anything frustrating about using the exhibit?**

*There were problems with the bands (5 of 9)*

You don’t, you don’t have the stuff to do it. [the stuff, can you say a bit more about that?] I ran out of those bands. I should come back later. You do not have what you need.

I was wondering if there was another band around. This kid was using it.

No. The strings tension. Wanted to demonstrate that the umbrella would do the same thing as that umbrella (the exhibit with the umbrella near by), but I couldn’t get it going the same speed.

The challenge drew us to it. We realized that is was like the car fan belt - really tight without re-wrapping - the belts are faulty.

The rubber band came loose. I was not sure how to put it back on. My boyfriend fixed it.

*There was nothing frustrating (4 of 9)*

No

No

No

No

**Question 3. Can you sort of go over with me what you tried at the exhibit and what you were thinking while you were using it?**

* Tried to make a pulley system (5 of 9) *

Try to move around strings and see what happens. Notice the differences. [And was there anything you were thinking about while you were using it?] Nothing in particular.

I tried to go faster than it was going when we got here. Which is the point. I don’t know much about those things, but he does (points to friend and laughs).

I tried spinning them and then making something else work.

I tried to connect the wheel together so they would all move. To figure out the best way to do that.

I wanted to see how it worked.


**Didn't realize you can move the pulleys around (2 of 9)**

I didn’t know you could change those things (the pulleys). Wasn’t intuitive. I guess I didn’t read the instructions. [And can you tell me a bit about what you tried at the exhibit?] I tried a few different things.

Thought about switching the blue and red bands. We never did it. We learned how you need to wrap it around. We couldn’t figure out what the extra pulleys were for? [When you say extra...? They show me. I realize they didn’t know they could move them.] Oh, we didn’t know you could move them. Of course, it is a peg board.

**Trying to adjust the tension (1 of 9)**

I was trying to get them tighter and tighter. It needs to be the right tight, or it doesn’t work. All I needed was 2, make that 3 more bands.

**Don’t know (1 of 9)**

I don’t know.

**Question 4. We are interested in learning about how visitors use exhibit labels? I was wondering if you had a chance to see the mail label near the bench or the 4 labels hanging below the exhibit?**

<table>
<thead>
<tr>
<th>Saw main labels</th>
<th>Saw hanging labels</th>
<th>Were they helpful?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes. They told you how to use it.</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Yes, Um. Oh. I didn’t really read it, just a cursory look.</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>Yes. It showed what we are trying to accomplish. Thought it was the instructions.</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Question 5. We're interested in finding out what makes visitors move on from one exhibit to the another. Thinking back on it, what was it that prompted you to move on to the next exhibit? Anything else?

Reason is extrinsic to the exhibit (5 of 9)
I think I spent enough time on it. It engaged the kids quite a bit. I was able to relax on the bench (laughs)
He called me over (to liquid litmus). I was going to go back over later (back to pulley table)
My attention span. I’ve done everything I could. We’ll probably not....(laughs)
I don’t know. (mom says, “Maybe because I said, Amanda come over here, look at this....”)
This one looked interesting (vibrating pin screen)

Reason is intrinsic to the exhibit (1 of 9)
After a few efforts, we couldn’t get the 3 fans to go. We said, let’s move on.

Reason is both intrinsic and extrinsic (3 of 9)
It was because I couldn’t do anymore. I choose to leave it. It is like being in a toy store.
You like a toy. And then another toy catches your eye. And you buy it. “buy” here is like play.
I don’t know. I saw what happens. You move on. This exhibit looked pretty cool. (circuit workbench)
I looked around - they looked similar (the wheels at this exhibit) I figured I was done exploring. I had enough.

Conclusions

The exhibit seems to be working well. Visitors are spending extended periods of time at the exhibit, more time than they did in the first version. The multiple stations seem to be encouraging more visitor groups to use the exhibit simultaneously. The mission objects seem to be engaging nearly all visitors in activity. The interview data suggest that the exhibit is fairly engaging (though the video data seem to indicate a higher level of engagement than the interview data). Even in Version 3, though, interviewed visitors did not always realize that the pulleys can be moved from one place to another.

The labels (main label + 4 experiment cards) seem to be having a limited impact. They did seem to lead to significantly more visitors using the music box. We recommend going back to the video data, pulling out those visitors who used the music box, and analyzing whether and how the label seemed to help them. This may shed light on the other labels and how they might be improved. In general, however, the exhibit seems to work well regardless of the presence of the labels. The interviews indicate that most visitors do not notice the labels.
The interviews found that visitors left the exhibit mostly for reasons that are extrinsic to the exhibit itself. This suggests that most visitors felt the exhibit was open-ended.

Acknowledgments

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