

3D Shapes

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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

3D Shapes

Formative Evaluation Report

Describing Versions 1, 3, 4 and 5

12/16/03

Josh Gutwill and Nina Hido

Goals

The developer of this exhibit, Diane Whitmore, has created different versions of the exhibit to determine which version best engages visitors in the activity of building 3D Shapes for an extended period of time. Of the different versions Diane has built, we have studied four of them (Versions 1, 3, 4 and 5). In this report, we analyze the holding time and shape-making behavior of visitors at each version of the exhibit.

Methods

This report describes four different versions of the exhibit. Table 1 shows the versions of the exhibit we studied.

Table 1. Versions of 3D Shapes studied

Versio n	Date	Number of Visitor groups studied	Description of Exhibit	Description of Label
1	1/6/02	47	Single color pieces Single color velcro	No Label
3	4/21/02	82	Single color pieces Single color velcro	4 Experiment Cards
4	2/8/03	68	Multi-colored pieces Gray & black velcro	8 Experiment Cards + “Make anything you want”
5	8/17/03 (behaviors) 10/12/03 (holding time)	24 53	Multi-colored pieces Gray & black Velcro Walls & benches around exh	8 Experiment Cards + “Make anything you want”

Note: The video on 8/17/03 in Version 5 suffered from inaccurate holding times, due to the evaluator changing the videotape while visitors were using the exhibit. Hence, that video was only used to analyze visitor behaviors such as number of shapes made. Video captured on 10/12/03 is used for holding time analyses of Version 5.

Table 2 shows a photograph of each version of the exhibit.

Table 2. Photographs of versions studied

Version	Date	Photo of Exhibit
1	1/6/02	Not available
3	4/21/02 4 cards	
4	2/8/03 8 cards + main label	
5	8/17/03 (behaviors) 10/12/03 (holding time) Walls around exhibit	

Videotaping

For each version of the exhibit, we videotaped visitors using the exhibit over the course of a weekend day. We then analyzed two to three hours of the video for each version. Table 1 above shows the number of visitors included in the study for each version.

Interviewing

For Version 5, on 10/12/03, we conducted exit interviews with 7 randomly-sampled visitor groups. The questions we asked were:

Question 1a: How engaging was this exhibit for you?

Not engaging Somewhat Engaging Engaging Very engaging

Question 1b: Can you say why you chose ____?

Question 2: Was there anything frustrating about using the exhibit? Anything else? [to exhaustion]

Question 3: Can you sort of go over with me what you built at the exhibit, and what you were thinking while you were building? Were you building with a plan, with a picture in your head, or did you just see how the pieces came together?

Impressions

The evaluators (Suzanne Buennagel and Joshua Gutwill) also simply watched videotape, and contributed their impressions about how visitors were using the exhibit.

Results

Holding time

An Analysis of Variance found that the log of the holding time for visitors significantly increased across the different versions, with Version 5 showing the highest holding time ($F_{3,246} = 2.56$, $p = .06$). (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 shows the holding time (in seconds) for each version of the exhibit.

Table 3. Holding times for each version of the exhibit

Version	Features	N	Mean (secs)	St. Dev (secs)	Range (secs)	Median (secs)	% of Vs spending more than 2 min
1	No Label	47	97	109	4-423	49	30%
3	4 Experiment Cards	82	112	165	3-864	52	23%
4	8 Experiment Cards	68	136	228	4-1577	55	31%
5	8 Cards w walls	53	193	238	6-1214	86	42%

Note: Post hoc tests found that the mean holding time for Version 5 was significantly higher than those of Version 1 ($p = .02$) and Version 3 ($p = .01$) and marginally higher than that of Version 4 ($p = .08$).

Figure 1 shows the holding times for each version.

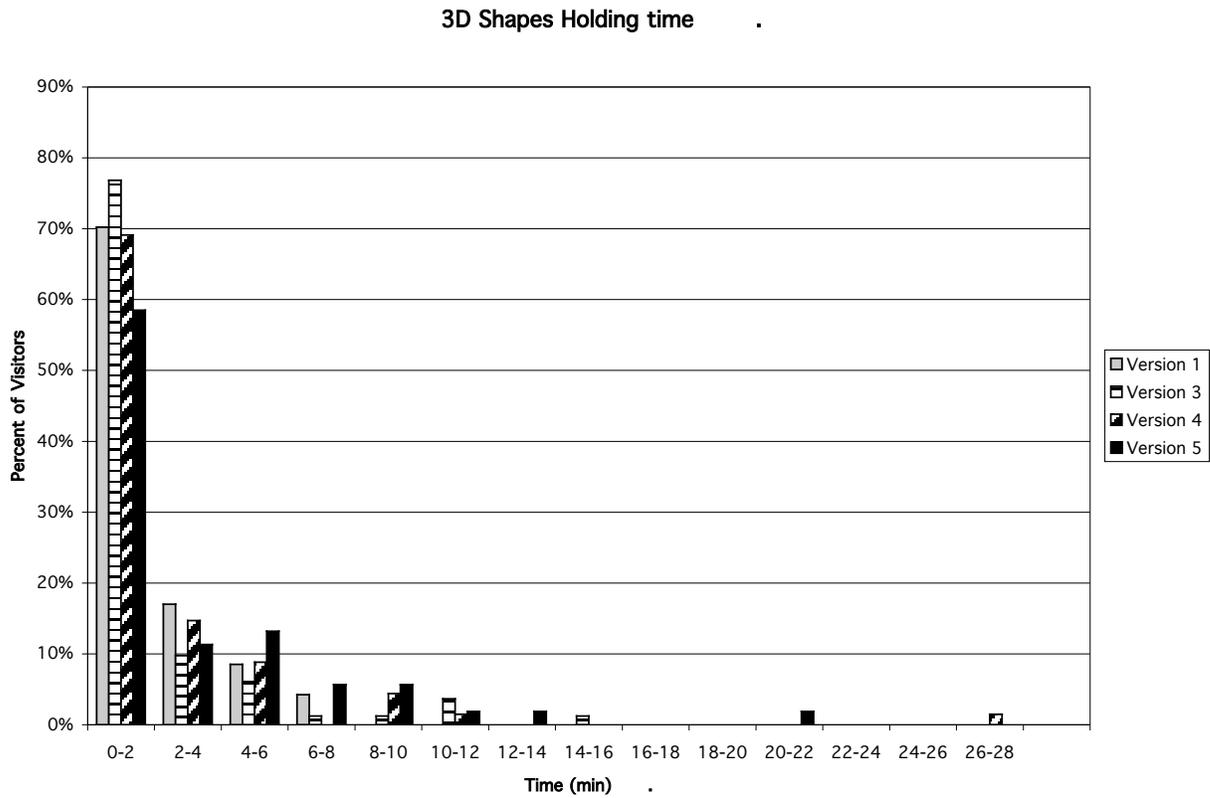
**Figure 1. Holding time distributions for each version.**

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 in Version 5 indicate a marked shift to the right.

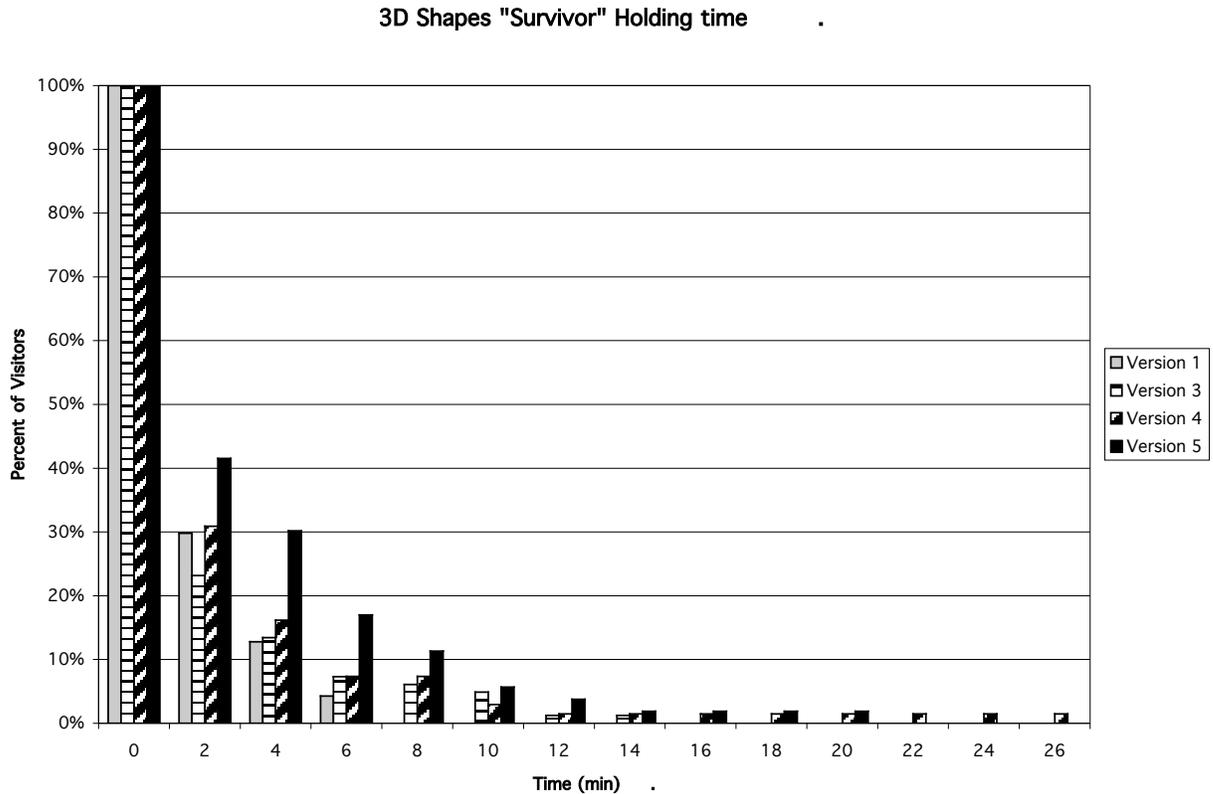


Figure 2. Survival plots of holding time for each version.

We also analyzed the holding times for “committed” visitors only, where committed visitors were defined as those who spend at least 10 seconds at the exhibit. The analysis excluded 26 “uncommitted” visitors across all four versions. We found no differences in committed visitors’ holding times across versions ($F_{3,220} = 1.33$, $p = .26$).¹ This is consistent with findings from the previous evaluation study (see the Appendix).

Making Shapes

¹ There were also no differences in the holding times of “uncommitted” visitors. Nor were there any differences across version in the relative number of committed and uncommitted visitors.

For Versions 3 and 4, we were particularly interested in determining whether having 8 experiment cards (Version 4) would encourage visitors to make more shapes than having only 4 experiment cards (Version 3). A shape was defined as three pieces connected together.

We found no significant difference across the two versions in the number of shapes visitors made. However, we did find that visitors who made two or more objects spent more time than visitors who made only one object. This need not be true, because visitors could simply build one very large, intricate shape. (Please see the Appendix, part of the Formative Evaluation Report for Versions 3 and 4 by Suzanne Buennagel, for details.)

For Version 5, we were also interested in the number of shapes visitors made, and in particular, whether they seemed to use the cards to guide their construction process.

In terms of the former issue, we found that visitors in Version 5 who made two or more shapes spent significantly longer than the visitor groups who made one or no shapes ($F_{2,20} = 18.2$, $p < .0001$). See Figure 3. See the Appendix for similar results in Versions 3 & 4.

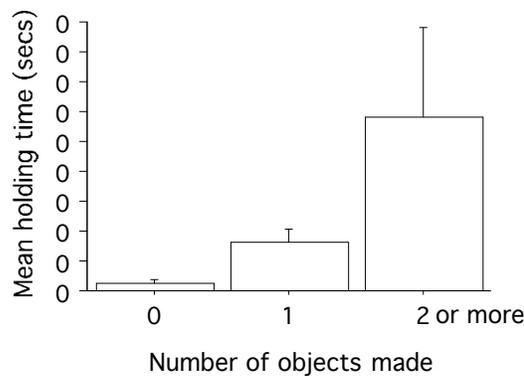


Figure 3. Holding times for visitor groups in Version 5 making 0, 1 or 2+ objects.

Using the experiment cards in Version 5

10 out of 24 visitor groups (41%) in Version 5 interacted with at least one experiment card in one of the defined ways. Some of these groups interacted with more than one card. The total number of cards with which visitor groups interacted was 23. Of the 10 groups who interacted with a card, 3 (30%) seemed to build the suggested shape. (This

also means that 3 of the 24 visitors (13%) used at least one card to build a suggested shape.)

An ANOVA found that the three groups who built shapes suggested by the experiment cards spent significantly more time at the exhibit than the groups who did not build shapes suggested by the cards ($F_{1,22} = 12.2, p = .002$). See Figure 4 for a graph of the mean holding times.

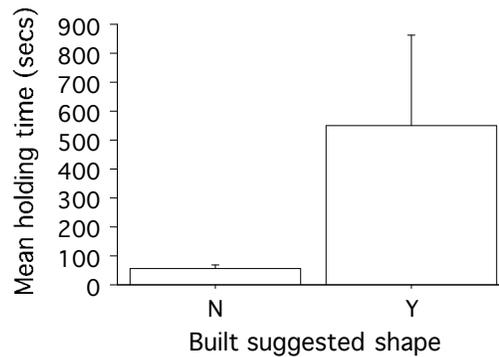


Figure 4. Holding times for visitor groups in Version 5 who did and did not build shapes suggested by the experiment cards.

Using the main label in Version 5: “Make Anything You Want”

Of the 24 visitor groups we observed, 2 (8%) read the main label aloud. Both of these groups also interacted with the experiment card labels. Of course, many more visitors could have read the label silently. In fact, one interviewee explicitly stated that she “liked the way they gave you ideas but let you build whatever” which suggests that she had read the main label and the cards.

Orientation of Velcro: Versions 3 vs. 4

Visitors seemed to have less trouble matching the Velcro pieces together in version 4, with the gray and black tabs. Although all visitors recovered in both versions, 8 had trouble in version 3 and only one visitor seemed to have trouble in version 4.

Placing walls and benches around the exhibit: Versions 4 vs. 5

Visitors spent marginally longer periods of time in Version 5 than in Version 4. There were two main differences in the exhibit across versions: (1) Existence of walls and

benches in Version 5 and (2) Date of data collection (2/8/03 vs. 10/12/03). Because this was a formative evaluation study, rather than a research study, we did not control for day of the year nor for exhibit location (Version 4 was recorded in the sound abatement area, while Version 5 was recorded in the prototype area). Hence, although we believe that adding walls increased the visitor holding time, it is possible that the time of year or location had undefined influences as well.

Visitors seemed engaged by exhibit in Version 5

The interview data for Version 5 indicate that overall visitors were engaged by the exhibit, did not find it frustrating, and were often intentionally trying to build particular shapes. The detailed interview results are given below.

Question 1a: How engaging was this exhibit for you?

Response	Number of visitor groups
Not engaging	0
Somewhat engaging	0
Engaging	4 (57%)
Very Engaging	3 (43%)

Question 1b: Can you say why you chose ____?

I could make many different shapes

I teach math and physics - the shape and pattern and things- I wanted to translate this into this [points to head and then to shapes]. This is better than - These pieces are better than anything like Tinker Toys, Erector sets, better than all those. The pieces are great. You have to try to fit them together.

I liked the way you could do anything you wanted. The way you put together the shapes, with velcro.

Make different shapes - it was fun. Stick with velcro- its fun. [Anything else?] Like making shapes.

It gave me ideas, but I could make whatever I wanted

You can make whatever you want. [Anything else?] It gave you ideas. [What of our ideas did you try?] A home and snowflake. [What of your own ideas did you build?] Star.

Girl #1: Some are difficult to connect. Velcro is coming off some. Girl2: It's hard to stack them. The boards need to be thicker, hard to make the roof connect to the sides. Woman: I liked the way they gave you ideas but let you build whatever.

I liked it

It was quite fun
Likes the things she can do. She made a bowl, but not anything else.

Question 2: Was there anything frustrating about using the exhibit? Anything else? [to exhaustion]

No

No
Not that I could tell
No. (see previous question)
No
No

No, but I did use the degrees on the pieces

No. I used the degrees on it. [What did you do with the degrees? Did they help you?] No, I just tried to make the shapes.

I had trouble finding the pieces

It was hard to find the pieces. [Did we not have the pieces you wanted to have, or were they hard to reach?] They weren't in my space [couldn't reach them].

Question 3: Can you sort of go over with me what you built at the exhibit, and what you were thinking while you were building? Were you building with a plan, with a picture in your head, or did you just see how the pieces came together?

Trying to make a specific shape (soccer ball: 4 groups. Other shapes: 4 groups)

The soccer ball. Wasn't sure at first... [What weren't you sure about?]
What shapes to use to make it come together. [But you figured it out]
Once we got it, it was easier. [I noticed you building some other stuff while your friend was working - did you have a plan, or were you just putting pieces together?] Not really {a plan}, when he needed the pieces I gave it to him. [Other comments or questions?] No.
It caught my attention by somebody building a soccer ball - I wanted to flatten it- with hexagons and pentagons. That was the first thing. The second thing, I wanted to build with a trapezoid for sides - I had to fiddle to find triangles and ___[didn't catch it] to flesh it out. Had an idea of what it would tak, to get it to come together like that. [So were you building with a purpose, or just putting pieces together?] Had a

picture in my head and I wanted to see if the mental image would translate into the shapes.

Tyng to build with pentagons, a dome structure, but couldn't do it. [What next?] Then used the pentagons and triangles to make a sphere. [Did that work?] Almost. [Did you ever manage to make a dome?] No, I gave up. [Did you build anything else?] No. [I noticed you tossing - were you testing it?] No, just messing around.

Ok. The last time I came here, I made a different shape. This time I made as soccer ball with the 108 degree pieces [did it work?] yeah. [What did you make the last time?] A box, a diamond. Today made a soccer ball. [What were you saying into the microphone?] Just about my favorite colors. [Any suggestions for us?] No, it's good how it is.

Girl 1: I first tried to make a spaceship, but then put ears on it and it looked like a mouse. Girl 2: I tried to make a house, but it looked like a basket. [was it the one on the picture?] yes. Woman: I was just making shapes - don't know -Ariel looked at it and said it looked like a toilet. [Plan or no?] No plan, just put pieces together, and apparently it turned out to be a toilet ! (laughing)

Just made a bowl.

Putting pieces together without a specific shape in mind

No. [Did you have a picture in your mind that you tried, or just put pieces together?] Just put them together.

Conclusions and Recommendations

Placing walls and benches around the exhibit seemed to significantly increase the holding time at the exhibit (assuming the nuisance variables are not responsible for the effect). Based on these results, we would recommend using benches and walls to make the exhibit's surrounding context more conducive to prolonged engagement.

The distribution of overall holding time for the exhibit, with or without walls, looks like an exponential decay curve, which is typical of Exploratorium exhibits. However, there was a substantial fraction of visitor groups (42% in Version 5) who spent more than 2 minutes at the exhibit, and several visitor groups who spent over 10 minutes. Our holding time data on Non-APE exhibits to date shows that only 10-25% of visitors spend more than 2 minutes at Non-APE exhibits. This suggests that the 3D Shapes exhibit successfully offers opportunities for visitors to become engaged in a prolonged manner.

We found a correlation between the number of shapes a visitor group made and the time the group spent at the exhibit, which suggests that getting visitors to build a second shape may be an important step in fostering prolonged engagement.

The data regarding the experiment cards also suggest some possibilities for encouraging visitors to become more engaged with the exhibit. The interviews found that the activity of making a soccer ball was fairly popular. The video data indicate that only a small number of visitor groups actually followed the suggestions offered in the cards. However, the groups that did spend significantly more time with the exhibit than those that did not. This suggests that the experiment cards, if interesting to visitors, may be effective at fostering prolonged engagement. We recommend trying out new card ideas with visitors in a quick-and-dirty way, perhaps by sitting at the exhibit and offering alternatives to see which ones visitors enjoy.

In the interviews, visitors reported feeling engaged with the exhibit, experiencing little or no frustration using it, and often seemed to be motivated to build particular shapes (i.e., they seemed to be building with intention).

In conclusion, this exhibit, particularly in Version 5, seems to be engaging visitors for an extended period of time in an enjoyable, easy-to-use activity of self-directed construction.

Acknowledgements

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Appendix: Excerpts of 3D Shapes Formative Evaluation Report

By Suzanne Buennagel

February, 2003

Results

Holding Time – Committed visitor groups only

Groups at 3D Shapes who did not ‘commit’ to using exhibit were not considered. Lack of commitment was considered visitors who used the exhibit for 10 seconds or less or, for example, touched exhibit as they passed by

Median holding time for all visitors committed to using exhibit.

Version 3 68 sec

Version 4 79 sec

Mean holding time for all visitors committed to using exhibit.

Version 3 128 sec

Version 4 151 sec

The difference in holding times for committed visitors between versions is not statistically significant ($p=0.64$).

The difference in holding times between committed visitors and all visitors is significant ($p= 0.38$). Removing visitors from the analysis that were not considered committed to using the exhibit changes the holding time.

Visitors Making Objects

Analyzing the videotape data in Versions 3 and 4, we counted the number of objects each group made. The results from that analysis are shown in Table 1 below. None of the apparent differences is statistically significant.

Table 1. Making objects in Versions 3 and 4.

	Version 3 (N=82)	Version 4 (N=68)
Groups making one or more objects	53 (65%)	49 (72%)
Average number of objects per group (excluding groups making zero objects)	2.62	2.88
Average number of objects per person per group (excluding groups making zero objects)	1.42	1.39

In version 3, twenty-three groups attempted suggested objects, and in version 4, thirteen groups attempted suggested objects. The number of groups attempting objects suggested on the activity cards was not significantly different between the two versions ($p= 0.20$).

Anecdotal notes about suggested objects:

- Because the card remained upright and easily readable in version 3, it seemed that visitors more immediately made the suggested object. A visitor would approach the table, read the card or look at the drawing, and then try to do what they saw on the card. However, in version 4, the cards did not stay up, and so visitors approached the table, perhaps saw a suggestion written on top of the card, attempted it first on their own, and if they got stuck, then pulled the card and read. Several occasions I made a note of this happening in version 4.
- Related to this, I think more visitors in version 3 may have stayed at the table when they approached because they had a concrete idea of what they were supposed to do. They came up, saw the card, knew what to do, and tried it. My impression is that some visitors in version 4 approached the table, looked at it and touched the cards, but left quickly after not seeing directions.
- While watching the video of version 4, I was impressed at the interesting and imaginative objects that visitors made. Bunnies, people, tall towers of alternating colors, and balls of varying shapes were all objects carefully crafted that were not on activity cards.

Quantity of objects and holding time

The analysis of how many objects visitors attempted or how long a visitor stayed at 3D shapes can be complimented by looking at these in combination. Although visitors may have stayed for a long period of time, they may have attempted few (though creative) objects. For example, a visitor could make only one exhibit in less than a minute, or could spend ten minutes working on one object.

Figures 2 and 3 show the distribution of holding time, corresponding to the number of objects made.

Visitors making only one object shows a normal decay curve, while the graph of visitors making 2 or more objects suggests a bell shaped curve (with relatively few visitor numbers).

Figure 2: Holding time for visitor groups attempting 1 object per person on average

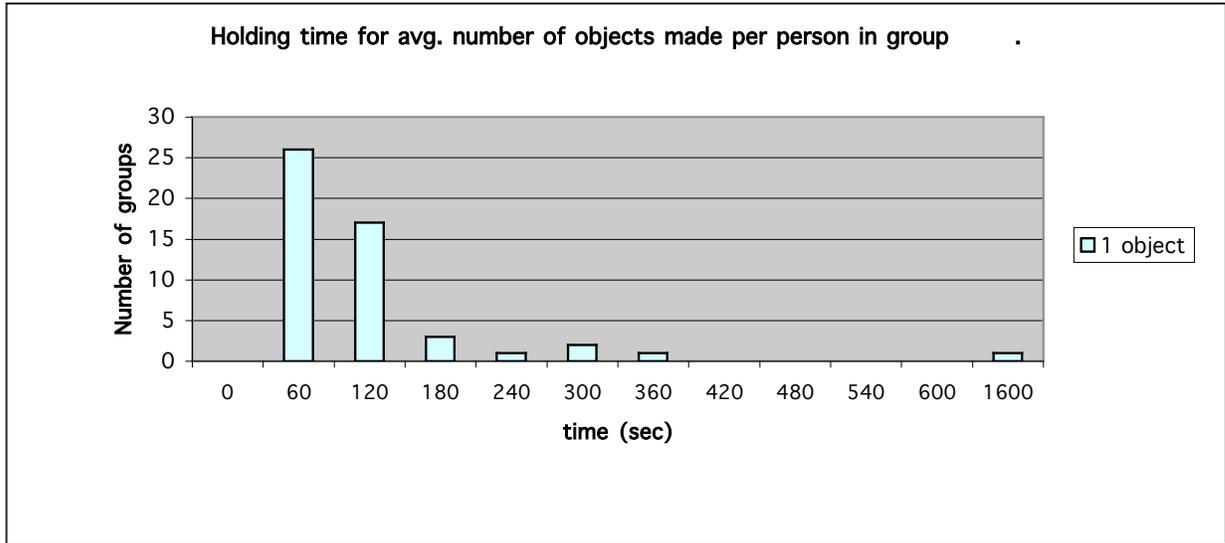


Figure 3: Holding time for visitor groups attempting 2, 3 or 4 objects per person on average

