Floating in Copper

Joshua Gutwill

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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

Floating in Copper

Formative Evaluation

10/7/01

Josh Gutwill-Wise

Goals/Context

The developer, Shawn Lani, wanted to determine whether visitors:

1) Understand that the magnets are not acting like "normal" magnets
2) Realize that the copper is not magnetic, but that it is affecting the magnets or magnetic fields
3) Get the feel of eddy current by moving the top magnet back and forth over the copper

Methods

Visitors were chosen at random as they crossed imaginary line. We used a cued interview format, meaning that we recruited visitors before they had seen the exhibit. It also means that the results of this study represent a "best case" scenario, when visitors know that they will be questioned while they are using the exhibit.

N = 25 Visitors
9 Males
16 Females

Age:

Years of age	Number of visitors
8-10	2
20-70	23

Summary of Findings / Conclusions

- Nearly all visitors (21 of 25) indicated that they understood that the magnets were not acting like normal magnets. (Goal 1) See Question 2. I would recommend no changes at this time to deal with Goal 1.
- Nearly all visitors (23 of 25) said that the copper was not magnetic, but that it was affecting the magnets in some way. (Goal 2) See Question 3. In fact, even the two children interviewed understood that the copper was not magnetic. I would recommend no changes at this time to deal with Goal 2.

- Half of the visitors interviewed (7 of 14) said that the copper explicitly slows down or reduces the effect of the magnets. (Goal 3) However, many more visitors (22 of 25) actually used the top magnet to move the bottom magnet, suggesting that they did feel the drag force of the eddy currents. See Question 3.5 and the Observations. I would recommend adding the "plug" of plexiglass that Shawn has already considered, in order to allow visitors to experience what happens when the copper is not between the magnets.
- None of the visitors mentioned "eddy currents" in their explanations. However, this was not a goal of the developer.
- The height of the exhibit seems too low for several reasons:
    - Several visitors complained that it was too low.
    - Several visitors had difficulty locating the bottom magnet.
    - Many visitors seemed to bend down in a awkward way to use the exhibit. I even witnessed a child of 3 years standing on a stool and having to bend down to look at the lower magnet.
    - The exhibit seemed difficult to use or uninteresting for children under age 7. They either lacked the coordination to make the bottom magnet float, or lacked the experience to realize that the magnets were behaving in a novel way. Hence, I would not take young children into account when determining the height of the exhibit.

  Due to these problems, I would recommend raising the height of the exhibit at least to one in which an average adult would be looking straight at the bottom magnet when sitting on a stool. If one wanted to raise it higher, I would put the bottom magnet at eye level height for an 8-year-old.

Detailed Findings

Observations

We observed visitors using the exhibit before we asked our questions. The observations are listed below:

	Performs action quickly	**Performs action carefully, repeatedly or systematically**
Reads Try this	1	17
Reads What's Going on	1	8
Watches others use exhibit	0	3
Pulls top magnet over copper	7	1
Moves bottom magnet	2	20
Floats bottom magnet	4	17

Questions

1. How interesting would you say this exhibit was for you? Would you say it was:

Response Scale	Visitors
Uninteresting	0
Somewhat uninteresting	0
Neutral	2
Somewhat interesting	9
Interesting	14

NOTE: Question 1 was included primarily as a warm-up question.

2. Can you say what it was that made it _____ for you?

Making the magnet float (13 of 25)

That the magnet can hover in mid air.

The explanation and trying to make it float as long as you could - it takes skill.

Making the magnet float.

Anything that simulates levity [levitation] is interesting. It's too hard to control for kids and toddlers.

Makes me think of space age stuff. Reminds you of being in space. The whole thought process behind it. Could keep you busy for hours trying to make it [float].

The idea of hovering in air. The magnetic forces.

It takes a bit of [gestures up & down with hands]. As it comes up and down, the closer it gets to one point or another, the more quickly it moves. At different places, you have more or less control over the magnet.

Just seeing the magnet float.

I've seen something similar to this before. The fact that it looks suspended in air. How slow it moves. The copper is so dense, for the magnets to go through it.

It made the other [bottom] magnet float off the ground.

Just the challenge of getting the bottom magnet suspended by holding the top magnet. Had to work at it.

I like that you can make it fly and when it hits the ground, it'll come back up.

Trying to make the copper [bottom magnet?] hover in mid air - that it does not just stick to the [top?] magnet.

Moving the bottom magnet & seeing its slow motion (4 of 25)

Just watching the magnet rotate underneath. And the speed of it - slower in reacting to the top magnet.

Nothing until I noticed the [bottom] magnet. I had to read it. A kid might not know what to do. [Once you knew what to do, what was interesting about it for you?] The way it moves. The tricks you can do with it. Have to move it slowly to make it follow.

The way the magnet moves. The way the bottom magnet, how you can maneuver it.

I didn't expect the way the magnetic effect was slowed down as if floating in a liquid.

Seeing what they do with amusement rides (3 of 25)

To learn - that it's what they use to stop amusement park rides. Because it relates to things I've done.

We played with this for a half hour last time we visited the museum. My son explained how they use this at Vertical Velocity at Marine World. I haven't been able to make it float like that.

Kept thinking about how they would use this in amusement park rides. Also the feel of it. You can see it and feel it.

Other (5 of 25)

The bottom magnet - it took me a second to figure out it even there. [And once you did?] It made me want to know more what was going on.

Interesting that although copper is not magnetic, with strong magnets, they create a magnetic field or orient the atoms so the magnets are attracted to it. The faster you move the magnets, the stronger the opposing forces - I don't understand that.

Not really sure what it is supposed to exhibit, other than magnetism

I don't think I learned anything from it, other than attract a magnet through copper.

I can play with it - do something for a few minutes.

3. Did you feel like the exhibit gave you a sense of which objects were magnetic and which were not? Y / N And what is your sense of which is which?

	Magnetic	Not magnetic	Not sure
Top magnet	24	1	0
Copper piece	1	23	1
Bottom magnet	24	0	1

3.5 Do you have any sense of what the copper is doing / effect it has? [Probe: And what if the copper were not here?]

NOTE: Question 3.5 was added late and so was only asked of 14 visitors.

Copper slows down or reduces the magnetic attraction (7 of 14)

The field is somehow distorted - slowing it down - somehow spreading out the field.

Slows the magnet - gives resistance

It would go right to the magnet. Copper is slowing it. It's a go between. [Don't know how it does it.]

The other magnet would attract to the other magnet [if no copper]. I think it [copper] like blocks the path of the magnet.

If it was a normal magnet, they'd just sit together. With this [copper], it slows it down and makes it not just hang or fall.

[If no copper] the two would stick together. Go straight up & down.

That's what causes it to hang in mid air because somehow it broke down the magnetic effect.

Copper creates or enhances the magnetic force between the magnets (4 of 14)

Creating force between the two magnets. Has to be there for it to work.

It's conducting it - it allows - it carries down the magnet's pull to the [lower magnet]

It helps transfer the forces exuded by the top magnet to the bottom magnet by creating forces in the copper itself.

[Without copper] wouldn't they behave the same? [What if there was nothing between the magnets?] It wouldn't work the same way. [So what's the effect of the copper?] Acts as a buffer between the two - helps the magnet attract each other.

Copper is simply in the way of the magnets (2 of 14)

[Copper] is stopping it. It's stopping the [bottom magnet] to get stuck to the [top magnet]. [I don't think she gets that the magnets were moving slowly.]

I think it's for only the distance. [For separation?] Yes. Yes.

Other (1 of 14)

Couldn't show the magnetic force that might go between something without it. I'm curious as to why it's built this way.

4. Have you ever experienced magnets behaving in this way before?

Totally novel	Have experienced before
17	8

Previous experiences mentioned:

We bought one of those spinning magnet tops, but it didn't work.
I rode the bullet train in Japan, and it used magnets to levitate the train.
Something to do with a paper clip holder.
I saw something like it on TV.
I saw something like this with glass.
I wrote a book on magnets, and we did something like this.
I've just played with two magnets.