

# How the Affordances of Materials Affect Visitors' Interactions with an Exhibit

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## ABSTRACT

This paper reports a formative evaluation of an interactive exhibit in the Museum of Science, Boston, that encouraged visitors to create a model using everyday materials. The materials provided for visitors to create their models changed during the period of the evaluation, and visitors were observed and interviewed as they engaged with the various prototypes. Evaluation results show that the type of modeling material presented influenced the visitors' model making process. When bead chains were provided, visitors created models that were highly detailed and incorporated aesthetic flourishes. In contrast, when pipe cleaners were provided, visitors created models that lacked details and only represented an object's outline form. The modeling materials also influenced group interactions. With the pipe cleaners, visitors incorporated their models into animated movements as a way of communicating what it represented. When visitors were provided with bead chains they used models created by others as a starting point for their own creative process. These results demonstrate how the affordances of different materials not only influence individual learning and behaviors, but also the interactions visitors have with each other.

As described by cognitive scientist Don Norman affordances are "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (Norman, 1988, p. 9). The affordances of a material or design greatly influence how people interact with the designed world. The concept of design affordances has implications for the way museum professionals design interactive learning experiences as visitor interactions with an exhibit are influenced by their perceptions of the types of actions that are permissible and possible given the interactive's design.

Museum research and evaluation studies have frequently documented that simple changes in design often correspond to alterations in visitor behavior and learning (McLean, 1993; Taylor, 1991). In some cases changes made to an exhibit reflect changes in

the design's affordances. When building *Making Models*, the Museum of Science in Boston extensively evaluated exhibit prototypes to explore ways to engage visitors in the science thinking skills of identifying, assessing, using and creating models. This report takes a close look at visitors' model making as they engage with one prototype component titled "Can you make a model of a...". It tells the story of the lessons learned by the exhibit team during the formative evaluation of the prototype, about how the affordances of the model making materials influenced the visitors' model making process.

### **History of the *Making Models* exhibit**

The purpose of this exhibit was to engage visitors in the process of creating models that someone else could understand. Visitors were presented with model material and a question: "Can you make a model

of a..." Following the question was a series of suggested items to model. It was the team's intention that through the process of creating their own models visitors would have the opportunity to enhance their creative thinking, a necessary skill for scientific model making (Penick, 1983). In addition, this component was created to provide visitors with experience creating simple yet effective models. Some models are just as effective, and in fact some are more effective, when they intentionally exclude details beyond what is necessary for the model's use. While this idea may seem simple, it addresses a difference between a child's and an expert's conception of a model. When discussing model design, children tend to focus on matching the model to "the real thing" while science experts focus on creating models that match the intended purpose with the fewest

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details possible (Grosslight, Unger, & Jay, 1991).

The first prototype was tested in February 2002. In its original form, visitors were asked to create pictures of everyday objects using simple shapes. All they were provided with were pencils and paper. In future iterations, visitors were asked to create models using blocks, Colorforms®, recyclable materials, and pipe cleaners. As the team altered the materials, the evaluators noticed differences in the types of models visitors created. For example, when visitors were provided with pencil and paper, they drew detailed pictures of people. With blocks, most visitors built structures such as bridges and buildings. With both of these materials, visitor perceptions of what the materials were useful for overrode the suggested list of possible models that was provided by the exhibit team.

Of the previously tested materials, pipe cleaners were found to be the best. The models created by visitors with pipe cleaners were diverse in character, and some represented abstractions such as verbs and adjectives. Unfortunately, the interactive in this format could not be sustained as a permanent activity. During formative evaluation, exhibit maintenance staff reported that the pipe cleaner holders needed to be refilled three or four times a day. To move ahead with the activity in this format would cost the Museum of Science roughly \$12,000 to \$13,000 a year in pipe cleaners!

Based on this financial reality, the team set out to create an alternative model making material that would have similar affordances to the pipe cleaners, but could be easily reused by the museum visitors. Affordance criteria included the following: is intuitive to use without directions, comes in

the form of a line that can be bended and curved (including by someone with limited dexterity), is available in multiple colors, is tactile and identifiable for visitors who are blind, and allows visitors to easily “undo” models created by previous visitors. A material that met these criteria was bead chain, which is a thin strand of tiny metal beads linked together to form a chain. The designers decided to supply visitors with bead chains in various colors, along with slanted magnetic boards where visitors could place the bead chains and move them around to form different textures and shapes. The boards were purposefully placed on a slant to allow for easy manipulation for persons in wheelchairs with limited reach.

As the exhibit team moved forward with this design, they decided to

explore and evaluate how changing the material would influence visitor model making and what would be lost or gained by using bead chains instead of pipe cleaners.

## METHOD

The evaluation of the bead chain version of this interactive was tested with visitors using a method and time period that was similar to the prior evaluation of the pipe cleaner version. Testing of the bead chain version took place during February School Vacation week 2003 in the *Making Models* prototyping gallery. This changing gallery was open to all visitors and signs were placed at the entryway to inform visitors they would be observed and/ or interviewed in this area. Included in the evaluation were un-cued visitors who approached

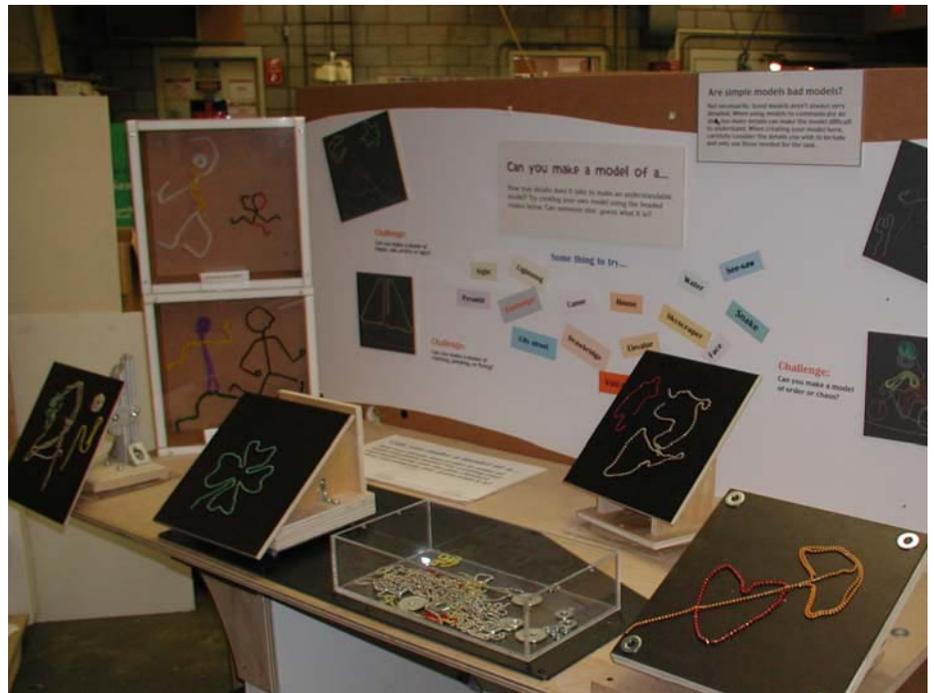


Figure 1: Making Models prototype in the production shop (This illustration shows both the bead chain models and the pipe cleaner models used in a previous prototype.)

the interactive and stood in front of it for at least 5 seconds. Following the observation, visitors were asked a series of questions. In total, 19 visitor groups (38 visitors) were observed and twelve groups were interviewed.

The bead chain prototype was similar to the pipe cleaner prototype, and consisted of the following elements (see Figure 1):

- A large panel that included an invitational question, a list of words that suggested ideas and objects for visitors to model, and a short paragraph describing the activity's purpose (the text was not altered from the original pipe cleaner version);
- Four slanted magnetic boards;
- Metal bead chains in a variety of colors and sizes;
- Bins for the chains; and
- Pictures of models created by other visitors.

## RESULTS

Visitors modeled a variety of objects using the bead chains. Of the 38 visitors observed, 28 visitors created 35 models. The remaining ten visitors either made abstractions (splashes of lines), or wrote their initials. Many of the models visitors made with the bead chains were of human faces (13 of 35). In this way, the bead chain models were similar to those created using pencil and paper where 18 of 36 models were representations of the human face. In comparison, only two of the 45 pipe cleaner models were faces. One reason visitors may not have made many faces with the pipe cleaners is that it is awkward to represent the empty space between the outline of the head and the inner eyes, nose and mouth using pipe cleaners, since this material best suits models that have interconnecting lines. One visitor started to create a

face using the pipe cleaners, but then stopped and said, "you can't really make a face with pipe cleaners."

Some of the models created using the bead chains were similar to the models created with the pipe cleaners. For example, models of pyramids, skyscrapers and snakes were constructed using both materials, these objects being mentioned in the label as part of the suggested list of objects to model. However, there were fundamental differences in the characteristics of the models created by visitors using bead chains as compared to pipe cleaners. Not surprisingly, models created with pipe cleaners tended to be three-dimensional, while models created with bead chains were two-dimensional. While it was possible for visitors to create 3D models using bead chains (by layering the chains on top of one another), visitors did not use the bead chains in this way. The models created by visitors using the bead chains also differed from the pipe cleaners in that they included full picture scenes that represented multiple objects placed together in the context of a scene. Visitor models created with bead chains also incorporated representations of the insides of the objects while the pipe cleaner models generally symbolized just the outline of the object's form.

The differences in the characteristics of the models created using bead chains as opposed to pipe cleaners are best exemplified by comparing the two skyscraper models: the pipe cleaner skyscraper consisted of two empty rectangular structures, each three dimensional in form; the bead chain skyscraper included not only the rectangular outline of the building, but also the building's internal windows and doors, and the sun in the sky next to its roof. These differences in the models' characteristics might reflect

how visitors worked with the materials. When creating models with the pipe cleaners, visitors tended to hold them in their hands up in the air. This process makes it difficult to create multiple objects in a scene as visitors can only hold one object at a time. In contrast, the bead chains were created on magnetic board. This surface can hold multiple objects at the same time and therefore is better suited for creating a full scene. It is also flat and somewhat vertical, like an artist's canvas, which implies that it was designed to suit the needs of two-dimensional artistic creations.

The models visitors made with pipe cleaners tended to have fewer details as compared to those made with bead chains. When visitors modeled people with the pipe cleaners they generally made "stick figures" that lacked details such as facial features (eyes, nose, and mouth), hands, and clothing (see Figure 2). In contrast, when visitors modeled faces with bead chains the models were highly detailed. The model faces not only had eyes, nose, and mouth, but some wore earrings and make-up. One adult spent over 5 minutes adjusting the hair of her person, slowly adding and removing lines, and curling each strand of hair. These differences again, may reflect distinctions in the affordances of the different materials. The bead chains are more malleable than pipe cleaners and could be easily manipulated into tight and tiny circles, and the curves of the bead chains could be softer and more exact.

### How Visitors Interacted with their Model and Each Other

Visitors' interactions with their models and each other also differed according to whether they used pipe cleaners or bead chains. With the pipe cleaners, visitors were more likely to "animate" their models and interact with them

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Figure 2: Pipe cleaner models created by visitors

using their whole body. This reflects the ability of models created with pipe cleaners to stand on their own, without the support of a background material such as a magnetic board or table surface. For example, one 9-year-old boy placed two pipe cleaners in a V formation on his hat and called himself a “TV.” Another 8-year-old boy made a lollipop and gestured with his tongue to indicate what his object was to other individuals in his group. A mother and her 4-year-old daughter wore the “model” ring and necklace they made. This affordance of the pipe cleaners, to be able to interact with the model through imaginary play, allowed some children to create models of objects they would not otherwise be able to represent. This is exemplified in the following scenario:

*A small boy, age 5, carefully chooses three pink pipe cleaners and twists them together in the*

*following formation: He then*



*turns to his mother and says “Mom, guess what it is.” When Mom can’t guess, her son starts to move his creation as if it was hopping up and down. The mother then exclaims, “It’s a bunny!” Her son looks pleased, puts his model down and begins to make another...*

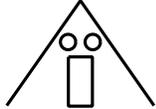
In this scenario, the child’s ability to animate his object affords him the opportunity to express himself beyond his current artistic capabilities. While the bead chains and magnetic boards did not afford visitors with the opportunity to animate their models, the affordances of the bead chains did allow visitors to create models that were based on the creations of previous visitors. With both the pipe cleaners and the bead chains, visitors were

observed creating exact replicas of the other models on display. However, with the bead chains, models created by other visitors not only served as examples to be copied, but starting points for creating new models. Visitors would simply adjust an old model to create a new model of their own. Sometimes the changes were simple, such as the 11-year-old girl who changed the expression of a face created by another visitor to make it “scared.” Other times, the changes were more dramatic. The way visitors interacted with the previous models to create new models is exemplified in the following description of one family’s interaction:

*A family of five walks up to the exhibit. The youngest girl, age 4, starts to modify a canoe made by a previous adult visitor. She removes some of the decorative elements and the person, and says, “It’s a boat and there’s the sun.”*

*Her older sister, age 6, goes to the board next to her. She stops and looks at the back panel and starts to make an up side down V on her magnetic board. Then she places two circles near the top, and a large rectangle in the middle, towards the bottom.*

*“Look what I made Mom!”*



*“What is it?” her mother asks. The girl says “A pyramid.” The mom says, “That’s a pretty big door. Who’s inside?” The girl then proceeds to add a long armed figure inside the door.*

*The younger daughter (age 4)*

walks away and the mother follows her. The father comes over and asks the girl, age 6, what she is building. She says "a pyramid." Mom, while standing at another component with the youngest daughter, responds and adds, "I think she is adding a person." "No," the daughter replies, "it's a mummy."...

The 6-year-old girl then moves to the board with the boat and starts to modify this model by adding a red flag, a big hump to the middle, and a person to the boat [in the interview, she revealed this was a pirate ship].

In this scenario, we can see that the ability to work from a previous visitor's model allowed the four-year-old child to immediately engage in the activity. It allowed her to recognize that these materials could be used to represent a boat, and then to form her own more simplistic representation of this object. For the 6-year-old, this affordance enabled her to easily modify her own pyramid model and improve it based on her mother's prompting. In addition, the boat model made by her younger sister became the starting point for creating a new model, a pirate ship, which is more detailed than either of the previous iterations.

When the exhibit team decided on a modeling material that would afford visitors the ability to "undo" the models created by previous visitors as a way to cut back on the maintenance of the interactive, they did not anticipate that this same affordance would also offer visitors the opportunity to build upon each other's work. This unanticipated consequence of the design serves to alter the experience in a positive way, allowing visitors to enter into

the learning experience at the level of creativity where they feel comfortable participating.

## CONCLUSION

The affordances of designs and materials can greatly impact the way an individual interacts with museum exhibits. In the case of the "Can you make a model of..." interactive, the visitors' perceptions of how they could interact with the materials greatly influenced the types of models they created and their interactions with others in the group.

In some ways the use of the bead chains as the model making material improved the experience for the visitors (such as offering them the opportunity to build upon previous visitors' models). In other ways, the change from pipe cleaners to bead chains was a step backwards as the models created by the visitors with the bead chains were more detailed and included more aesthetic flourishes than those created with the pipe cleaners. Thus, the use of the bead chains decreased the interactive's ability to convey the scientist's conception that effective models include only the details that are needed to complete the task.

When museums make "small" changes in design such as altering materials for model making, the impact on the visitors' experience is potentially significant. The findings from this evaluation support the need for alternative designs to be thoroughly tested with visitors so that the exhibit team is aware of the ways their design decisions might influence visitors' interactions with the exhibit, and each other.

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