Design Challenge Resource Collection

Module7: Prototyping Design Challenge Exhibits

This module is part of a Design Challenge Resource Collection, developed by a cross-functional team at the Oregon Museum of Science and Industry (OMSI) with decades of experience conceptualizing, developing and building museum exhibits. The collection is intended to support exhibit developers and designers as they work to create interactive design challenges.

These modules are designed for someone to read individually or facilitate with a team. There are great benefits derived from collaborating on the exhibit development process. Throughout the modules, activities for groups of individuals are called out in blue boxes.

Team Activity

Discussion prompts and other activities for groups are in blue boxes like this one.

Each module stands alone; there is no specific order to explore the modules, nor is there a need to read them all. However, in some cases, references are made between modules for opportunities to learn more. Finally, these resources are not meant to be prescriptive, but rather examples, tools and approaches the OMSI team has found valuable in the development of non-facilitated engineering design challenge exhibits for the museum floor that are accessible, relevant and engaging for visitors.

The entire set of resources can be found on the *Design Challenge Resource page*

1. Introduction to Design Challenges
2. Exploring Design Challenges
3. Approaches to Exhibit Accessibility
4. Testing a Design: Measures of Success.
5. Exhibit Design Sprints
6. Graphic Development for Design Challenges
7. Prototyping Design Challenge Exhibits
8. Participatory Co-development of a Bilingual Exhibit
9. Documenting Exhibits: The Exhibit Record Tool

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Prototyping Design Challenge Exhibits

A good design challenge exhibit provides visitors with the opportunity to explore a variety of materials and use them to create, test and iterate a wide range of engineering design solutions. Creating an experience like this, however, can be a real challenge for exhibit developers - especially for a non-facilitated exhibit. Coming up with a compelling way to engage visitors in exhibit content through a design challenge, manufacturing a safe and reliable testbed for designs, and finding materials that are durable enough for everyday use while still allowing visitors the freedom to engineer creative and successful designs can seem near impossible. One key to successfully developing a design challenge exhibit is prototyping. Testing out ideas and materials early in the development process will help ensure that the exhibit will be engaging, intuitive for visitors and (hopefully) within budget. This module describes various stages of prototyping and testing that exhibit developers at OMSI use when creating design challenge exhibits, and provides examples of how decision-making at the different stages might save time, and money in the long run while informing the development of a successful exhibit.

Developing a Design Challenge Exhibit

Developing an engineering design challenge exhibit is, in many ways, an engineering design challenge itself. Developers define visitor learning and experience goals, identify criteria and constraints, brainstorm ideas (See Module 5: Exhibit Design Sprints), consider benefits and trade-offs, and plan, build, test, evaluate and iterate their designs to optimize a solution. Like the engineering design process, exhibit development goes through cycles of testing and iteration, learning and improving through each cycle until the final product is presented to the visitor. This module presents four high-level stages of prototype testing that are often used in exhibit development: Proof of Concept, Prototyping, Formative Evaluation, and remediation, though each often involves multiple cycles. The sections below describe each stage and provide examples of how prototyping informed decisions for exhibit development for *Creatividad silvestre | Wild Creativity*. Descriptions of the components can be found in the *Creatividad silvestre | Wild Creativity Exhibit Brief*.*

Proof of Concept

During the conceptual phase of exhibit development, many ideas are generated for experiences that could support the learning and experience goals of an exhibit. It is at this point that proof of concept prototypes can help to narrow the field of viable ideas. While something may seem like a surefire way to engage visitors in exhibit content, reality often presents a different view. Testing potential ideas early can save the team from investing time and resources in pursuing an idea that would not be feasible for the museum floor.

*https://omsi.edu/wp-content/uploads/2022/11/CSWC_exhibit-brief_12.2022.pdf

Team Activity

Have an idea for a new design challenge exhibit? Make sure it's feasible with a proof of concept. Use materials you have around to test the idea to make sure what you think will happen can or will actually happen.

- What is the goal you want visitors to achieve?
- How will designs be tested (Check out Module 4: Testing a Design - Measures of Success for details)?
- What is the phenomenon you want to demonstrate?

Think about how you could explore whether the idea is viable. Look online to see if someone else has already done something similar and recreate what they did. Think about the materials you would need to test it yourself. Get creative; look around your kitchen or garage, storage rooms at your institution, and grab some cardboard from the recycling bin. Education and programs departments often have lots of cool materials that might help you test.

Now, try it out. Can you build a design that will achieve the goal? Show the phenomenon? Does reality match what you imagined? If not, would different materials make a difference? Make small investments to see if you can get the results you want.

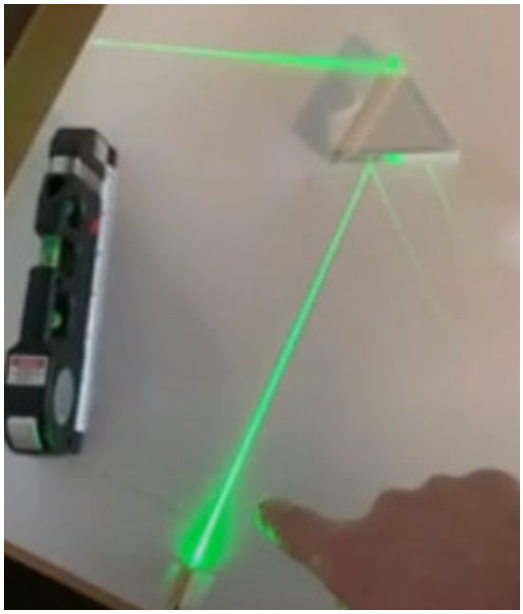
The purpose of proof of concept prototyping is to explore the potential and feasibility of an idea, and it is often done with cheap or on-hand materials. For the *Creatividad silvestre* | *Wild Creativity* exhibition, a few examples of proof of concept prototyping include testing for exhibits about decreasing the urban heat island effect with total internal reflection, generating electricity with wind, and bouncing balls to a target.

The concept for "Vuela | Fly" was to challenge visitors to mimic natural strategies like those of flying squirrels, maple seeds, and gliding birds to design, build, and test kite models that generate electricity. The original idea was for visitors to generate electricity by creating a design that either spun or generated lift. Using an existing wind tube, the team tried a variety of off the shelf materials (e.g Tinker Toys) as well as consumable materials such as paper, playing cards, popsicle sticks and pipe cleaners to create designs.

Proof of concept models for lift and spin in a wind tube

To test whether the idea of total internal reflection could be seen, the team created a simple light box using a cell phone flashlight and file folders along with a prism borrowed from the physics lab. While not ideal, this simple prototype was used to share with the team how light can be redirected through a prism by changing the angle of incidence.

With the success of this proof of concept, the team purchased additional prism shapes, and worked to improve visibility of the light beam by trying a laser level borrowed from the fabrication workshop, and eventually purchasing a high-powered green laser.



In the “Salta/Jump” exhibit, visitors are challenged to adjust the drop height of a ball and the angle of trampolines to bounce a ball into a target. One of the first tests was making sure that we could bounce a ball across a series of platforms. The original prototype was an acrylic tube, a ping pong ball and three squares of plywood.

Once bouncing on platforms was deemed feasible, designers created a foam core, cardboard and tape model that more closely resembled the imagined final product.

In both of these examples, prototyping started with very inexpensive materials or items that the team could gather from around home or work to demonstrate a particular phenomenon or process. Small investments were then made to complete the proof of concept.

Not all ideas pass the proof of concept testing. One potential exhibit was to challenge visitors to create reflective clothing using structural color inspired by natural examples such as morpho butterflies and peacock feathers. The idea was to explore examples of structural color from nature to see how well they reflected light, and incorporate those into designs to increase the visibility of bike riders at night. The team collected natural examples from OMSI's LIFE Lab, and a light meter from the planetarium, then tried detecting the amount of light each item reflected.

While promising at first - different samples did indeed reflect detectably different amounts of light - ultimately, it was determined that this was not feasible for an unfacilitated experience. The natural examples were quite delicate, and would need to be protected by encasing them in clear acrylic. Once this was done, the acrylic itself also reflected the light which interfered with the results.

Prototyping

Formal prototyping is a longer process than proof of concept in which more robust versions of exhibit designs are built, tested and improved to start fine tuning the experience. For “Salta/Jump”, this was done by fabricating a wood and PVC version.

The next interaction introduced a second drop tube and three separate targets. This version also tested a means to move the position of trampolines; this idea was ultimately abandoned.

This stage of prototyping is an excellent opportunity to explore different materials. Many different types of balls with different weights and sizes were tested on the “Salta/Jump” exhibit. Those that were most successful were evaluated based on durability and cost before an ultimate decision was made.

The “Vuela | Fly “ exhibit went through extensive prototyping in this stage where the team further tested different construction materials and tried to devise a means to actually measure the spin and lift generated by a design. A force meter and tachometer were purchased and successfully tested. The team had hoped to have a single test station where the spin and lift created by a design were measured simultaneously, but could not make this work.

The choice of materials remained an issue for some time. It can be very difficult to find the right build materials for an unfacilitated design challenge. Consumables can be expensive and put a heavy burden on staff to replenish and clean up. Sturdier materials, on the other hand, often don’t allow for the open ended and creative potential that would be ideal. Furthermore, some durable items are appealing to visitors and have a tendency to “walk off”.

Formative Evaluation

The formative evaluation stage is an opportunity to test exhibit designs with the public to see whether they understand the challenge, how they will use the materials, how they engage with the exhibit, and how successful they are with their designs. It is a chance to see all the unexpected ways people might use (or abuse) the exhibit, and is a great opportunity to get insights into accessibility. Formative evaluation can help identify ways to make exhibits more accessible for people with different kinds of learning needs. A detailed discussion of accessibility can be found in Module 3: Approaches to Exhibit Accessibility. Examples of observation forms for formative evaluation can be found in appendices A and B.

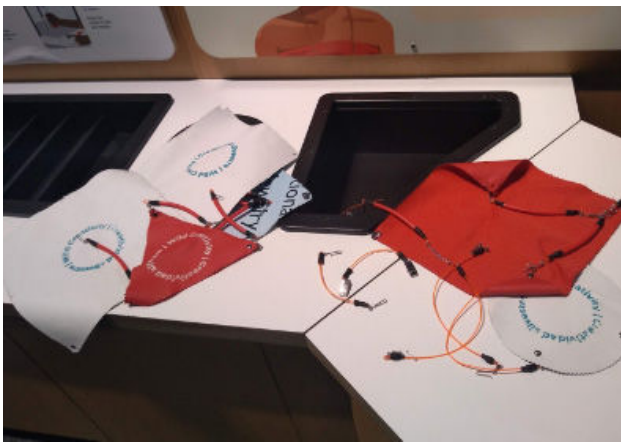
For formative evaluation, there were two stations at the “Vuela | Fly” exhibit: one where people could test designs that spin created with off the shelf and 3D printed durables, and another where they could test designs that created lift made with construction paper and pipe cleaners.

Both stations functioned well under testing, however, there were safety concerns with the spin station. In addition, it was determined that the materials at the spin station did not provide a significant range of designs. After formative testing, it was decided to move ahead with only the lift station at “Vuela | Fly”.

Remediation

Remediation is an opportunity to make final adjustments to an exhibit after installation. While it is often too late to make major changes to an exhibit, small tweaks can be made to improve the exhibit and experience. After *Creatividad silvestre* | *Wild Creativity* opened to the public, it became clear quite quickly that the use of consumable materials (construction paper and pipe cleaners) may not have been the best choice for “Vuela | Fly”. Visitors were not reusing and recycling materials as the team had hoped, and were often not cleaning up after themselves; the time and cost of replacing and cleaning up materials would not be sustainable. The team moved toward durable materials that could be reused. A variety of materials were tested both in the exhibit shop by the team, and later on the floor with visitors. The final kit of durable

materials included a variety of fabric shapes of different weights with flexible connectors. These provided visitors with an opportunity to systematically test different variables and optimize their design.



Tips and Advice

Developing a successful design challenge exhibit is no easy task. You want visitors' creations to do something surprising or delightful when they're successful. With the wide range of visitor ages and abilities, challenges should be straightforward enough that people feel good about the experience, but also rich enough to hold the attention of dedicated creators. Test beds are difficult and often expensive to design and build, but they are key to a good unfacilitated design challenge - a necessary investment for a great experience. Design challenges also involve the choice and ongoing maintenance of materials and material management. While there is no secret recipe for a successful exhibit, prototyping along the way can help save time and money while working toward an experience that is the best it can be.

Test early and often: Start with proof of concept testing to help ensure your team is not investing time and money into an idea that might never work. Continued testing through prototyping, formative evaluation and remediation will help to iterate and refine the exhibit.

Involve people with different perspectives: Throughout the development process, get input from a variety of audiences. Ask staff from different departments to participate in early prototyping. Invite groups from target and anticipated audiences to see how different people use and interact with the exhibit.

Feedback from diverse perspectives will help result in an exhibit that is accessible, engaging, and successful for a broad audience.

Be creative and try lots of ideas: Prototyping is an opportunity to test new ideas and approaches. Finding something that works is great, but the first solution is not always the best. Try alternatives and trade up as development continues.

Appendix A: DOT Engineering Challenge Observation Form

Date:	Observer:
Group number:	Time Spent:

Group ages: 0-2____ 3-5____ 6-8____ 9-11____ 12-14____ 15-18____ 19-25____ 26-49____ 50+____
(↑ Write M for each male, F for each female, X when no guess is made)
Notes about the group:

Focus/Attention: (C=child, A=adult)	Collaboration (✔️ for yes, ⭐ for intergenerational)
_____ Low (repeatedly looking at phone or looking away, wandering away, making half-hearted attempts) _____ Med (moderate focus, 3 minutes or less, attempts full activity at least once, stays engaged with one part of activity but not the entire activity) _____ High (reading instructions, multiple attempts, spend at least 3 min, eyes and hands stay on activity)	_____ Reading instructions together (w/ interaction, e.g. pointing, reading aloud) _____ Helping w/ build or design (hands on) _____ Talking about build or design (e.g. making suggestions or asking questions) _____ Communicating about results (e.g. cheering success, reading feedback screens together) _____ Other:
What does the group do at the exhibit component? (2-3 sentences summary of what happened)	
Group understands what the prototype is about: ▫ Yes ▫ No ▫ Somewhat	Points of confusion:
Activity started: ▫ Smoothly ▫ With issues: ▫ Exhibit did not function for them: Notes:	Activity completed: ▫ As intended ▫ Unexpected (explain below) ▫ Multiple times ▫ Not at all Notes:

Appendix B: Creatividad silvestre|Wild Creativity Component Observation

Date: _____ Observer: _____

Group description: Age: 0-2____ 3-5____ 6-8____ 9-11____ 12-14____ 15-18____ 19-25____ 26--49____ 50+____
Notes about the group:

Component (circle): Entrance Flea Kangaroo Bird Beaks Prairie Dogs Workshop Helmet Kites Garden BIA

Time at the component (approximate time the group spent at the component)

What did you see that was interesting to you?

What did you see that was surprising to you?

What did you see that might be concerning or dangerous?

Other thoughts or comments: