Design Challenge Resource Collection

Module 4: Testing a Design - Measures of Success

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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Testing a Design - Measures of Success

Prior to developing an engineering design challenge exhibit, it is important to consider how the visitor will receive feedback on their design and how they will determine whether their design is successful in meeting their goal (and potentially, to what degree). This resource will explore different ways visitors can receive feedback and determine the success of their designs, establish some definitions for measures of success, provide examples of different approaches and consider the pros and cons of each.

Introduction

In this document, feedback is defined as the information a visitor receives from an exhibit. This can take many forms from: lights, sounds, haptic experiences (e.g. vibrations, or blowing wind), observable phenomena and others. Measures of success are specific types of feedback that allows a visitor to decide whether their design works (or not) at a challenge.

Measures of success are essential for design challenges. Engineering design challenges often center around criteria for success; whether these are defined for the visitors, or if they create those criteria themselves, there has to be a way of comparing your performance to those criteria to determine if you are successful. Without these measures of success, visitors wouldn't know if their designs work or not. The form of the feedback can greatly influence the visitor experience.

The measures of success can greatly enhance the visitor experience by

- Helping participants define the challenge itself. What are they trying to do? How do they know they have succeeded?
- Providing feedback that allows visitors to quickly assess their designs.
- Encourage iteration—if the participants can easily compare versions of their designs, they're more likely to try again.

Assessing Goal Completion

There are a variety of ways visitors can assess the success of their design—the extent to which it met their goal, or not. The measures of success may be qualitative or quantitative.

Qualitative assessments determine goal completion in terms relative to a general standard, a second design, or previous performance. Terms such as higher, faster, and lighter suggest qualitative measures. Performance assessments that are pass/fail are also considered qualitative. Did the tower fall? Did the egg break? Did the bridge hold? These are qualitative pass/fail assessments. Some examples of qualitative assessments are

- My turbine is spinning faster than yours.
- This bridge held more weight than our first bridge.
- The ball made it above the line.
- Our house survived the earthquake.

Quantitative assessments measure success in terms of a numerical or empirical standard. If there are numbers involved, it is a quantitative measure. For example, your turbine is spinning 6 rpm, or our bridge held 2.4 kilograms. Weight, time, wind speed, and RPM are all quantitative measures. When using quantitative assessments, remember to think about what units to use and how to present them.

There are pros and cons to both qualitative and quantitative measures, and there is no one approach that works best for every exhibit experience. Depending upon the challenge, the target audience, and the experience you want for visitors, you may choose either one or a combination of both.

Presenting Feedback

After considering the type of measure your exhibit will use, you need to think about how you will provide that information to the visitor. Feedback can be categorized as physical or digital.

Physical forms of feedback are directly experienced by the visitor. They can be measures taken with analog devices such as a ruler or a balance, or observations of whether a design met a determined criteria for success,such as floating, hitting a target or passing a finish line.

Digital forms of feedback are often screen-based or auditory and can be simulations, sensor outputs , augmented reality, or motion capture.

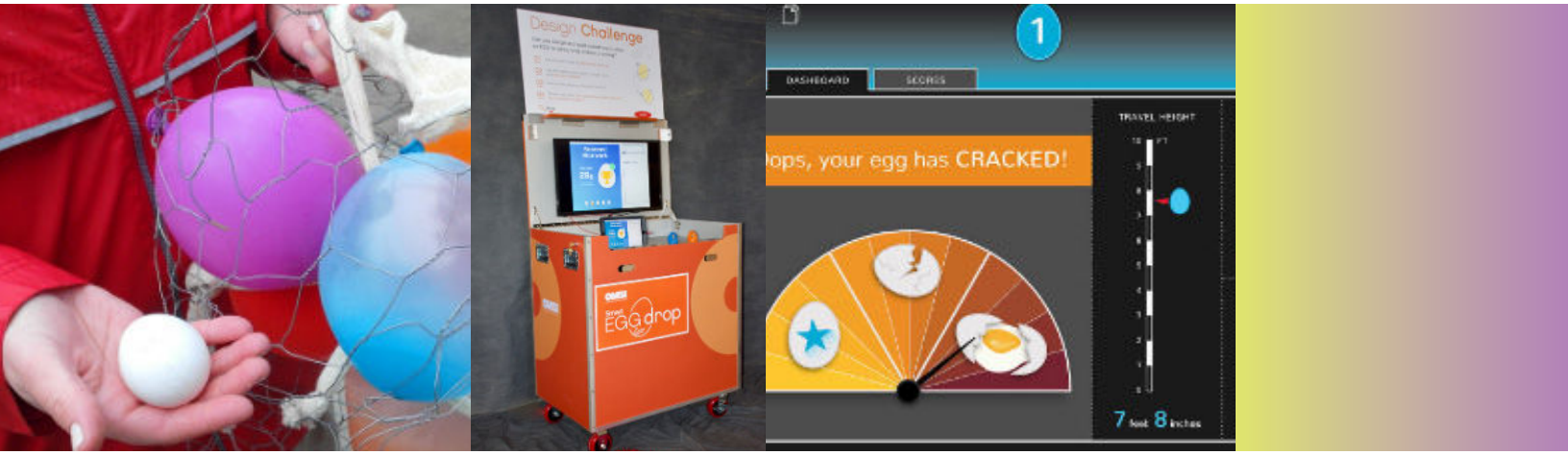
Both physical and digital data can be qualitative or quantitative and be perceived by multiple senses (e.g. visual, auditory, haptic). You may choose to use either depending on your audience, the challenge itself, and the overall goal of the exhibit. Similarly, you may choose the type of sensory feedback provided for a variety of reasons including accessibility, redundancy, or compatibility with the activity.

Examples

Egg Drop

The egg drop is a classic challenge. Whether the egg is being dropped from a helicopter, off the top of a building, or from a tabletop, the challenge is the same: design a means of protecting an egg from a fall. Traditionally, success of the design is measured using physical/ qualitative data. That is, you look at the egg and decide whether it broke or not. This is a pass/ fail test of the design.

OMSI developed an artificial “smart” egg that contains digital sensors that provide qualitative and quantitative data after they are dropped.



The digital presentation provides both qualitative (your egg has cracked) and quantitative (travel time, height, G-forces) data about the drop

Design a Wheelchair

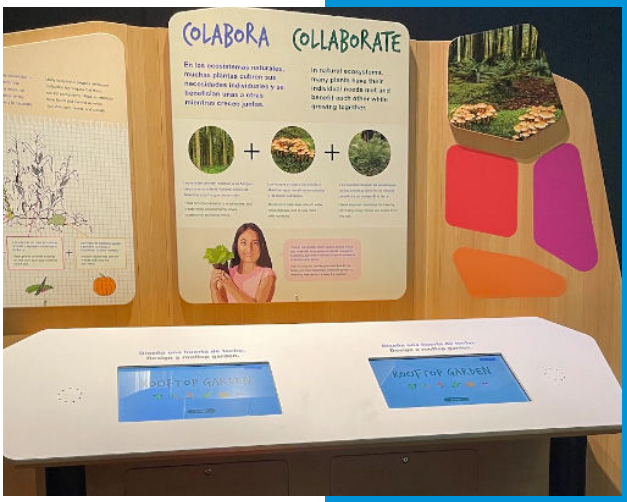
In this computer interactive challenge, two wheelchair users each present a scenario for wheelchair designs: going to the beach and dancing. Visitors choose types of frames, seats, front casters, back wheels, and accessories that are pictured on plastic blocks, arrange them in a design panel, and virtually test their new design. Feedback from the user tells the visitor whether the design is a success, or if it needs improvement. Onscreen messages help the visitor understand the tradeoffs of design decisions and how to better meet a user’s needs.

Lessen the Hot Spots

"Lessen the Hot Spots" challenges visitors to design a neighborhood that helps people stay cool. Visitors place blocks representing buildings and trees in the neighborhood, and can change the color of roofing materials. An image of the area from an infrared camera is shown on a screen representing the temperatures resulting from the design. The thermal image includes a color gradient that provides qualitative, digital data showing areas that are cooler (purple) or warmer (yellow) as well as a quantitative mean temperature (in Celcius) of the entire area.

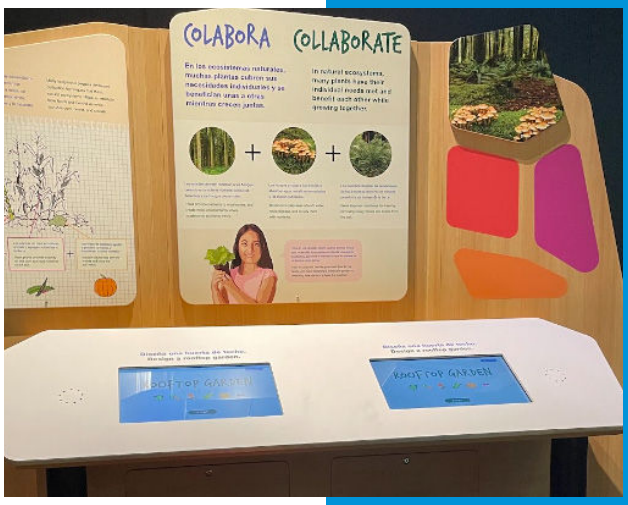
Collaborate

Visitors design a rooftop garden to grow fresh produce. This digital simulation provides quantitative feedback on the yield of the garden in a variety of ways: a number representing the total crop yield, one to five stars, and images of crops in each plot Examples of two different garden designs are shown below). Sounds play as the crop yield counts up, as each star is added, and once a total is reached. The end sound differs based on the yield of the garden.



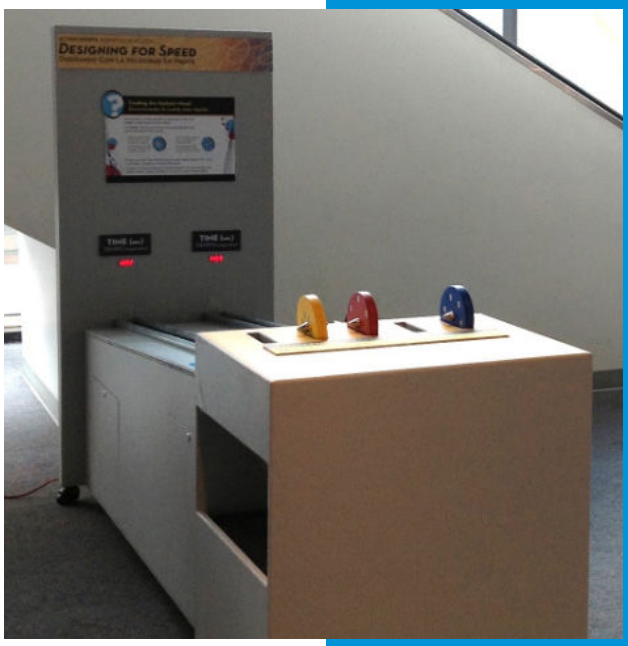
Build a Boat

At “Build a Boat,” visitors are not given a specific goal, but several different purposes of boats are described to spark their imagination (e.g. haul goods, transport people, race). It is then up to the visitors to decide whether the goal is to get their boat to float, to go fast, to carry cargo, or whatever else they might define as their criteria for success. Success at this exhibit is physical and qualitative.



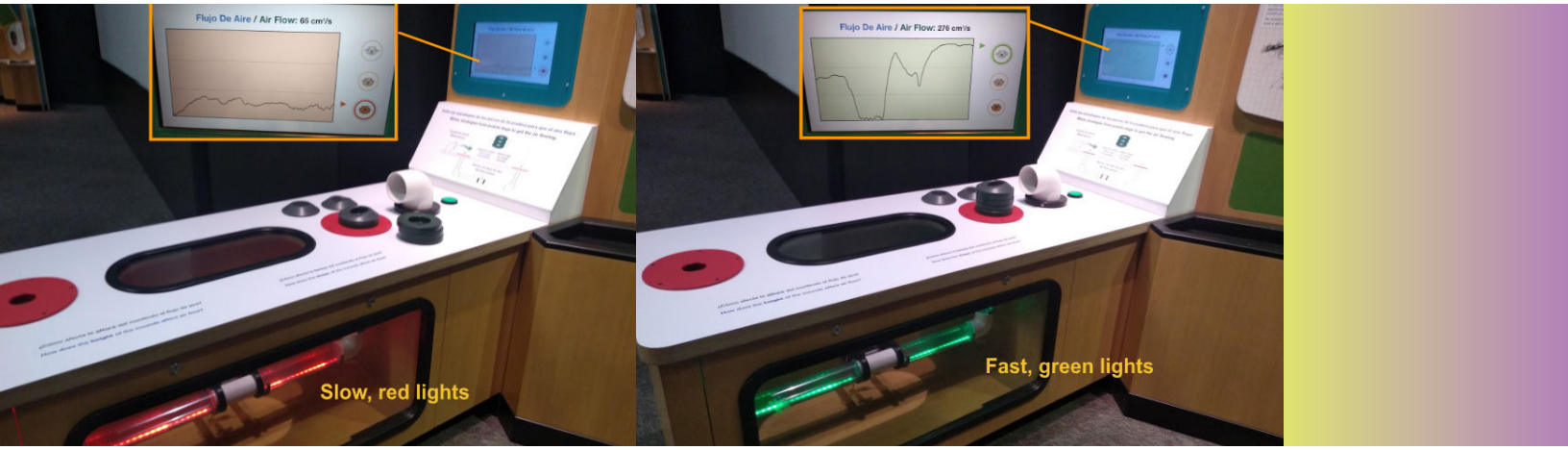
Designing for Speed

Which wheel design will make it to the bottom fastest? At “Designing for Speed,” visitors select from three wheels with different weight distributions and roll them down an incline. The goal is to have the fastest wheel and visitors can assess their success purely with physical, qualitative information by which wheel gets to the bottom first. The exhibit also has a timer that provides quantitative digital feedback.



Ventilate

How do prairie dogs keep their tunnels cool? Visitors design entrance mounds that create passive ventilation inside a tunnel. Feedback at this exhibit is primarily digital, including lights and sounds. The screen shows quantitative (numerical wind speed) and qualitative measures for the air flow in the tunnel (a graph of air flow and a prairie dog face expressing comfort or discomfort). As the air speed inside the tunnel changes, the pitch of a tone changes and lights inside the tunnel change color and speed.



Comparing Approaches

Feedback in design challenges can be effective in a variety of forms and combinations depending on the activity, audience, and experience goals. Below are some considerations when thinking about different approaches.

Physical, qualitative feedback is very intuitive; it is often easy for visitors to interpret and connect the result to what they are experiencing. It's straightforward to observe when a scale is balanced or a boat sinks. The first hand experience of seeing, feeling, and/or hearing how a design performs can be engaging. When your sailboat speeds away, there is a visceral sense of success. But, how fast did your boat go? Did adjusting the sail make it faster? These questions are difficult, if not impossible to answer with only physical/qualitative feedback.

Many times physical, qualitative feedback is in the pass/fail category where testing the design can leave it unusable for future tests (like an egg drop). While there is nothing like the drama of adding weight to your bridge until it comes crashing down, this type of destructive testing makes iteration difficult. Cycles of design, test, and improve can be impossible with some pass/fail setups.

Physical, quantitative feedback adds the potential for more accurate measures of success and side-by-side comparisons. Analog scales, rulers, calipers, and anemometers are examples of tools that provide physical/quantitative feedback. Quantified measures can allow visitors to compare different iterations of their design or finely tune their degree of success. There are, however, limits to the types of outputs that can be measured with analog tools, and if visitors are not familiar with the tools or how to use them, they may not use them successfully.

Digital, qualitative feedback gives exhibit developers the opportunity to show visitors things that might not be possible with a physical experience. Simulations and augmented reality can provide approximated qualitative feedback from other planets, allow visitors to iterate designs for a city transit system that could not be built as a physical model on the exhibit floor, or complete design tests that would take months or years in the real world. These experiences can be very compelling, though they lack the hands-on, direct engagement of physical exhibits. Planning and programming simulations can be expensive and time consuming. Variables, the relationships between them, and outcomes (sometimes hundreds of them) need to be defined and qualified. Once the programming is complete, maintenance can be minimal, but the front-end investments are significant.

Digital, quantitative feedback can come from sensors in the form of instantaneous, and very accurate information. Digital sensors are small, widely available and relatively affordable—all positive features for incorporating them into an exhibit. It's important to avoid non-intuitive 'black box' digital outputs by contextualizing the data outputs in creative data visualizations or sensory signals that complement the design challenge activity (e.g. presenting the information with a graph, chart, size, count, tone, or some other form). The accuracy and ease of use make digital outputs excellent choices for many experiences. Calibration and maintenance of digital sensors can require special expertise and frequent upkeep.

Considerations

The effective forms of feedback in each design challenge depends upon many factors. Consider the list below, your priorities, and how different feedback approaches will impact the experience when planning your design challenge.

Experience Goals - What do you want visitors to do? What do you want visitors to learn? How do you want the visitors to feel? What types of feedback will effectively communicate this to your audience?

Process Goals - What part of the design process are you highlighting? How can the feedback approach scaffold and encourage more of those processes?

Accessibility - What considerations can be made to increase usability? What feedback can you add (visual, auditory, or haptic?) to make the experience more accessible?

Spatial Goals - How much space is available for testing designs and receiving feedback?

Sustainability Goals - What materials are needed for design and testing? Can they be reused or recycled? How quickly are they consumed? How will they be restocked?

Maintenance Goals - How easy is the activity and the feedback to maintain?

Target Audience - Who are you hoping to reach with the exhibit? How do the goals and context of the challenge resonate with your intended audience? See “Design Resource 9: Co-Development” for a discussion on the importance of audience considerations and context around design challenge exhibits.

Team Activity

Use the Feedback and Measures of Success Planning Sheet to start thinking about an exhibit experience. Discuss the following questions with your team.

How defined is the challenge goal? Can multiple goals be assessed with the feedback you are providing?

How does digital feedback enhance a design challenge? What about physical feedback?

What could be some potential downfalls to incorporating digital feedback?

What are the benefits of qualitative feedback for the experience you are planning? What about quantitative feedback?

How could adding multiple representations of data improve the experience? How might they confuse or complicate the experience?

Many of these questions can be resolved and refined in the prototyping process. See “Design Challenge Resource 8: Prototyping” for a deep dive into testing ideas for design challenges and selecting materials that will work for the exhibit floor.

Feedback and Measures of Success Planning Sheet

Who is the target audience for this exhibit?

What is the goal of the challenge? What are visitors trying to achieve?

How will designs be tested?

What does a successful result look like? An unsuccessful result?

Make a list of the feedback that visitors could receive. Is it physical or digital? Qualitative or quantitative?

What feedback can you add (visual, auditory, or tactile, haptic) to make the experience more accessible? To complement or enhance other feedback?

Consider the lists above. What are the top three ideas to move forward?

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Physical	Digital	Qualitative	Quantitative