Creatividad SILVESTRE
La biomimesis transformando nuestro mundo

WILD Creativity
Biomimicry changing our world

Exhibit Summative Evaluation Report

Prepared for the **Oregon Museum of Science and Industry** by **Rockman et al Cooperative** as part of the project, **Designing Our Tomorrow** – Mobilizing the next generation of engineers

Rockman et al Cooperative
Research & Evaluation

Credits

Summative Evaluation: The summative evaluation of *Creatividad Silvestre | Wild Creativity* was a collaborative effort between the Engagement Research and Advancement team at the Oregon Museum of Science and Industry and Rockman et al Cooperative (www.rockman.com).

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EXECUTIVE SUMMARY

Creatividad silvestre | Wild Creativity is an exhibit designed by the Oregon Museum of Science and Industry (OMSI) in collaboration with community partners as part of the larger Designing Our Tomorrow project, funded by the National Science Foundation. The exhibit weaves together themes of biomimicry and sustainable design with hands-on Engineering Challenges designed to engage girls ages 9-14 and their families with engineering practices. This culminating piece of the Designing Our Tomorrow Project was hosted at OMSI and the Fleet Science Center in the final year of the project.

The OMSI Engagement Research and Advancement team collaborated with Rockman et al Cooperative – an education research and consulting firm – to conduct the summative evaluation of the exhibit. The research questions for the summative evaluation looked at the success of the exhibit in terms of 1) visitor engagement – whether visitors enjoyed themselves, saw personal relevance in the exhibit content, and were interested in its educational themes; 2) engineering practices – whether the design challenges presented throughout the exhibit prompted visitors to engage with various key engineering practices identified through an extensive research process; and 3) visitor understanding and awareness – whether the exhibit successfully conveyed information about biomimicry and engineering. To answer these questions, the evaluation team conducted surveys and interviews with groups exiting the exhibit to look at self-reported attitudinal and awareness outcomes. The team also conducted observations throughout the exhibit to look at engagement levels with different key components and groups' use of different engineering practices at the design challenges.

Findings from this summative evaluation show that visitors reported high enjoyment of *Creatividad silvestre* and positive reactions to both the biomimicry content and the engineering content. The examples from nature made a particularly strong impression on visitors, as did the Engineering Challenges – which were a favorite element for most interview participants. Visitors were also observed showing prolonged engagement with the individual components of *Creatividad silvestre*, including both the Engineering Challenges and the "Pillars" which conveyed key exhibit themes. Many participants completed the Engineering Challenges multiple times, often iterating on their designs.

Participant feedback also shows that many visitors found the exhibit relevant to their own lives. Participants especially appreciated that the exhibit was presented in two languages. Whether through its imagery, examples, language, or content (all carefully chosen to be inclusive of diverse demographics and communities) *Creatividad silvestre* prompted most visitors to think about solving problems in their own lives or communities. They were less likely, however, to have noticed or absorbed the stories the exhibit included about people around the world who are solving problems in their own communities through biomimicry solutions. These stories were often incorporated into videos or text panels that visitors may have overlooked.

The Engineering Challenges that visitors enjoyed engaging with were also very successful at prompting the use of a wide variety of engineering practices. Most groups were observed to use at least five different engineering practices at the informed proficiency levels identified in the C-PIECE Framework – a scheme the project research team developed to categorize engineering practices by both skill level and stage in solving an Engineering Challenge. Both child-only groups and intergenerational groups were observed to use a variety of engineering practices; however, observation data also suggests certain practices might emerge more often in particular group types – e.g., where there is an adult who likes to read instructions or a young sibling who watches an older one. The practices were also observed across the six different Engineering Challenges at which researchers collected observation data, showing all of the challenges were successful at eliciting multiple engineering practices at the intermediate and informed skill levels from groups.

While visitors both engaged at length with the Engineering Challenges and reported high enjoyment of these, they didn't necessarily see *Creatividad silvestre* as an exhibit about engineering. Most visitors did not talk about engineering in describing the exhibit, although 69% did agree with the statement, "In this exhibit, I felt like I was doing things an engineer would do." A strong majority of survey participants also reported high levels of efficacy and confidence relating to the Engineering Challenges and designing solutions to challenges. *Creatividad silvestre* used the words "biomimicry," "design," and "sustainable" frequently, but the word "engineering" did not appear often, and visitors may therefore have been less aware of this learning goal for the exhibit.

In contrast to engineering, visitors' awareness of the nature themes through *Creatividad silvestre* was quite high. Eighty-three percent of exit interview participants mentioned animals and/or nature when describing the main idea of the exhibit. Almost half of the participants recognized that the examples from nature presented through the exhibit are intended to teach about nature's strategies. Only about a quarter of participants said that these examples were also intended to show how humans can learn from nature. Participants also reported fairly low awareness of the term "biomimicry" in their exit interviews. Only 22% said they understood or somewhat understood this term. While they might not have absorbed this particular vocabulary word from *Creatividad silvestre*, exit survey data shows

that the exhibit did get many visitors thinking about "how nature can give people ideas on how to solve human problems."

On the whole, the greatest successes of *Creatividad silvestre* were in engaging visitors with hands-on engineering challenges that prompted groups to employ important engineering skills, while incorporating content and examples that felt relevant and interesting. The exhibit was highly enjoyable for visitors, who paid attention to the themes of nature and animals and the idea that we can learn from nature's examples – even if they didn't absorb the term "biomimicry" specifically during their visit. The exhibit evaluation raised interesting questions about collaboration and group dynamics in the context of design challenges, and how these factors influence visitors' use of different engineering practices. It also demonstrated that bilingual exhibits are welcomed by many visitors, and are not a barrier to visitor engagement. As a capstone of the Designing Our Tomorrow project, *Creatividad silvestre* has made important contributions to OMSI's ongoing efforts to engage girls and their families in engineering.

INTRODUCTION

Creatividad silvestre | Wild Creativity is a traveling museum exhibit for families and one of the major final achievements of the **Designing Our Tomorrow: Mobilizing the Next Generation of Engineers** project, led by the Oregon Museum of Science and Industry (OMSI).[1] This multi-year project, funded by an NSF Advancing Informal STEM Learning award, brings together resources and programs that weave together themes of engineering practices, biomimicry, and sustainability, while incorporating the perspectives of the broad and diverse audiences that OMSI seeks to serve. In particular, the bilingual (Spanish/English) *Creatividad silvestre* exhibit is designed to support girls ages 9-14 and their families, including those from Latino communities, creating opportunities for these groups to engage with engineering practices in ways that feel authentic to their own experiences. The exhibit was completed and opened to audiences at OMSI in Portland, Oregon in mid-March 2023. After running for six months, the exhibit traveled on to Fleet Science Center in San Diego, California in October where it ran through early May 2024. This report presents findings from the summative evaluation of *Creatividad silvestre*, a collaborative effort between the research team at OMSI and external partners at Rockman et al Cooperative, an educational research and evaluation firm.

Development and Goals of *Creatividad silvestre*

The Designing Our Tomorrow project and *Creatividad silvestre* build on earlier work by OMSI under the Designing Our World project. Designing Our World also sought to engage young women in engineering through a variety of program offerings, a partnership with local community organization Adelante Mujeres which serves Latina girls, women, and their families, and an exhibit that provided hands-on engineering challenges and highlighted the importance of engineering to people's lives.

In Designing Our Tomorrow, OMSI has continued to engage young women with engineering practices while adding in new thematic content around sustainability and biomimicry. The museum developed a partnership with the Biomimicry Institute for this project while maintaining its relationships with the Fleet Science Center and Adelante Mujeres.

> "Biomimicry is about valuing nature for what we can learn, not what we can extract, harvest, or domesticate. In the process, we learn about ourselves, our purpose, and our connection to each other and our home on earth."
>
> From the Biomimicry Institute website, "What is biomimicry?" Accessed Mar 3, 2024. https://biomimicry.org/what-is-biomimicry/

[1] More information about the Designing Our Tomorrow project, as well as resources for museum professionals, can be found at https://omsi.edu/for-museum-professionals/designing-our-tomorrow/

Through culturally-responsive co-development and research strategies that include members of Latino communities and provide challenges that highlight the altruistic, creative, personally relevant and collaborative aspects of engineering, the Designing Our Tomorrow exhibition showcases engineering as an authentic, everyday activity for everyone, and helps families support each other's engineering practices.

Broad Theme: *Creatividad silvestre | Wild Creativity* is an exhibition about sustainable engineering practice through the lens of biomimicry.

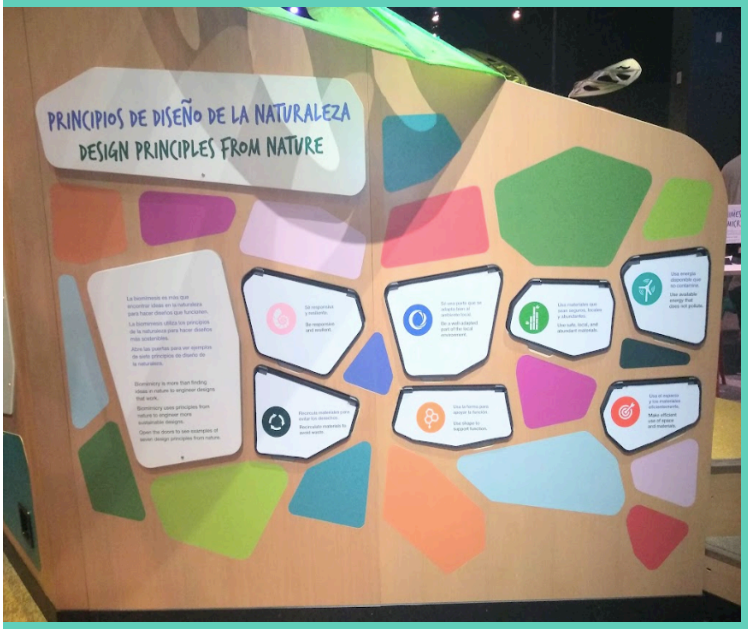
Big Idea: Biomimicry engages us with nature's strategies to design solutions for the challenges we face in our own communities around the world.

Target Audiences: Girls aged 9-14 and their families

Languages: Spanish-English bilingual, leading with Spanish

Host Sites: Oregon Museum of Science and Industry, Portland, OR

Fleet Science Center, San Diego, CA



Biomimicry is the practice of looking to nature for inspiration and problem-solving strategies that can drive human innovation. This concept provided an exciting new angle for presenting engineering challenges, and *Creatividad silvestre* incorporates many examples of how strategies from plants and animals are the starting point for tackling diverse human problems. The exhibit also highlights sustainability – a theme that is closely tied to biomimicry – to show how human ingenuity inspired by nature can lead to solutions that are better for our planet.

While promoting messages around biomimicry and sustainability, the project team has also sought to advance professionals' understanding of engineering practices and how to promote these in informal learning environments. A key deliverable of the project is the theory- and evidence-based Framework of Collaborative Practices at Interactive Engineering Challenge Exhibits – the C-PIECE Framework.[2,3] This organizational tool developed by the Designing Our Tomorrow research team summarizes an array of practices related to engaging with engineering challenges. The framework organizes these into two categories of proficiencies with three levels each – beginning, intermediate, and informed (see Appendix, p. 40). This framework was developed through an extensive research process including literature reviews, iterations of family observations, and conferences with researchers, educators, community partners, topic experts, and project advisors.

Engineering, biomimicry, and sustainability were all combined into the content and design of *Creatividad silvestre* and its objectives for visitors:

- Advance engineering proficiencies for the benefit of families, communities, and society
- Advance sustainable engineering attitudes, especially in girls
- Communicate the power of biomimicry to tackle local and global challenges

[2] Randol, S., Benne, M., Herrán, C., Ramos-Montañez, S., & Shagott, T. (2021). The C-PIECE Framework: Collaborative Practices at Interactive Engineering Challenge Exhibits—A Graphic Research Summary. Oregon Museum of Science and Industry.

[3] Randol, S., Benne, M., Herrán, C., Ramos-Montañez, S., & Shagott, T. (2024). The C-PIECE Framework: Documenting Group Engineering Practices Elicited by Design Challenge Exhibits. *Visitor Studies*, *27*(1), 49–75.

Co-Creating in Designing Our Tomorrow

In addition to these thematic content areas, *Creatividad silvestre* and the larger Designing Our Tomorrow project were also driven by a co-creation approach, where the voices from Latino communities were elevated to help drive decision-making processes. The exhibit development process involved more than just creating Spanish and English text; for visitors, the process also embraced a fully collaborative relationship with members of Latino communities. OMSI describes the participatory co-development process for *Creatividad silvestre* in the Design Challenge Resource Collection,[4] another resource for informal science professionals produced by the project:

> The *Creatividad silvestre | Wild Creativity* project is designed to privilege voices from growing Latine communities through co-development and partnering with an organization that is led by and serves Latinas and their families, staffing project leadership and advisor positions with members of Latine communities, engaging members of Latine communities through project development and working with the public in Spanish and English.

The OMSI team made specific efforts to involve families from Latino communities throughout the front-end and formative evaluation of *Creatividad silvestre*, and they also gathered feedback from members of these communities on all levels of the exhibit development process, incorporating their expertise in defining the exhibit goals, crafting ideas and language, making design and imagery decisions, and deciding what impacts were important to measure. This co-development process is intended to build strong relationships between community members and OMSI, and also to make sure that exhibits like *Creatividad silvestre* resonate with broad audiences and present content that feels relevant to people's lives.

A family gives feedback on an activity design

EXHIBIT EVALUATION

The summative evaluation of *Creatividad silvestre* was a collaborative effort between OMSI's internal Engagement Research and Advancement team and external research partner, Rockman et al Cooperative (REA). Senior researchers from OMSI and REA devised an evaluation strategy aligned with the goals of the overall Designing Our Tomorrow project and designed to provide evidence of the potential impacts outlined in the project logic model.

[4] Design Challenge Resource Collection. Oregon Museum of Science and Industry. https://omsi.edu/for-museum-professionals/designing-our-tomorrow/design-challenge-resource-collection/

Summative Evaluation Research Questions

The summative evaluation of *Creatividad silvestre* was guided by the following research questions:

Engagement, Interest, and Relevance

- Do visitors enjoy the exhibit and engage with its components? Do visitors report enjoying the experience and getting value from it? Do they demonstrate sustained engagement with exhibit components and activities?
- Does *Creatividad silvestre* increase visitors' interest in biomimicry and engineering? Do participants report increased interest? Do they spend time designing solutions at the "Do Biomimicry" station?
- Are exhibit themes and challenges framed in a way that visitors find culturally or personally relevant? Do visitors report relating to the exhibit examples?

Demonstrating Engineering Practice Skills

- To what extent does the exhibit encourage the use of engineering practices? How do families approach the Engineering Challenges? What techniques or strategies do they use? How many practices do they employ in the course of completing a challenge?
- What kinds of collaboration and problem-solving take place in the exhibit? Do groups work together to tackle the Engineering Challenges? Do individuals support each other's use of the engineering practices? Does intergenerational collaboration take place, and how often?

Developing Awareness, Understanding, and Confidence

- To what extent does the exhibit expand visitors' understanding of biomimicry and sustainable design? Do visitors understand the main exhibit concept and the use of examples from nature? Do they draw connections between animal/plant examples and human problems and solutions? Do they talk about examples from the natural world leading to more sustainable solutions?
- To what extent does the exhibit expand visitors' understanding and confidence around engineering practices? Do visitors report using engineering practices in their engagement with activities? Are they aware that they took part in engineering practices and design in the challenges presented? Do they report increased confidence for engaging with engineering challenges?

Target Audience

Creatividad silvestre and the Designing Our Tomorrow project more broadly are designed with girls ages 9-14 and their families in mind. In all research activities, the team therefore sought to recruit and focus on groups with girls in this age range as the first priority. To make the best use of time and resources, the evaluation also included families with girls ages 9-16 (second priority) and families with any children ages 9-14 (third priority), when first priority groups were not available. The final samples for each method described below contained at least 80% of groups aligned with these targets. (Full details on group compositions can be found in the Appendix under Sample Characteristics, p. 52).

TARGET GROUP INCLUSION IN SAMPLE

93%	exit interviews
80%	exit surveys
97%	observations at Pillar exhibits
96%	observations at engineering challenges

Methods

The summative evaluation of *Creatividad silvestre* used a mixed methods design to gather both qualitative and quantitative data on the visitor experience. REA and the OMSI research team devised an exit interview/survey protocol, and two types of observations in order to gather first-hand feedback from visitors, as well as an outside perspective on how they interacted with exhibit elements. The team focused on the family/group as the primary unit of analysis according to OMSI's usual research strategy and also collected data on the target individual within each group. For example, interview questions were posed to groups as a whole, but researchers made an effort to make sure target individuals responded whenever possible. Data collection took place at OMSI from August through early September of 2023 and at Fleet Science Center during November 2023.

Exit interviews/surveys – The goal of the exit interviews and surveys was to capture evidence of self-reported attitudinal and awareness outcomes. Researchers recruited groups as they left the exhibit. The protocol contained a small number of open-ended questions (less than ten) designed to explore the extent to which visitors absorbed the exhibit's key concepts (engineering, biomimicry, sustainability). Researchers recruited families with children in the target groups (see Audience above), and directed questions specifically to children in those target groups when possible. Once the interview questions were complete, an adult from the group was asked to complete a demographics form while the target individual completed the survey questions on a tablet. Each group received a small incentive as a thank you for their time (a $5 Amazon gift card). At Fleet Science Center, where groups were recruited in advance to come to the museum specifically to view the exhibit and take part in evaluation activities, a larger incentive was used ($20 Amazon gift card).

DATA COLLECTED

116	exit interviews
98	exit surveys
102	observations at Pillar exhibits
139	observations at engineering challenges

Figure 1. **Proportion of Interviews Paired with Tablet Survey** (n=116)

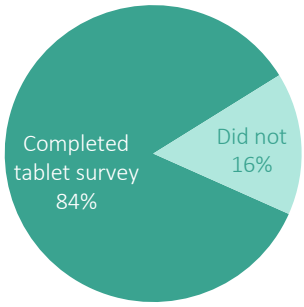
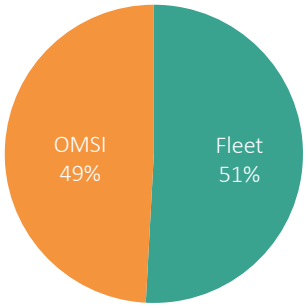


Figure 2. **Exit Interviews Conducted, by Site** (n=116)



Engineering Observations - The goal of these observations was to examine the extent to which visitors engaged in various engineering practices that are identified in the C-PIECE Framework (see Appendix, p. 48) while interacting with six different Engineering Challenges presented in *Creatividad silvestre*. Observers also tracked visitors' level of engagement and instances of collaboration – particularly collaboration between individuals of different generations. The observation instrument was developed by the OMSI team during the remedial evaluation process and modified slightly for use in the summative evaluation. Data were collected by group, with data collectors targeting groups according to the priorities described above.

Figure 3. **Engineering Observations Collected, by Site** (n=139)

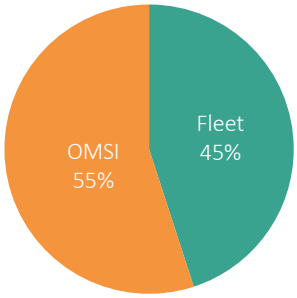
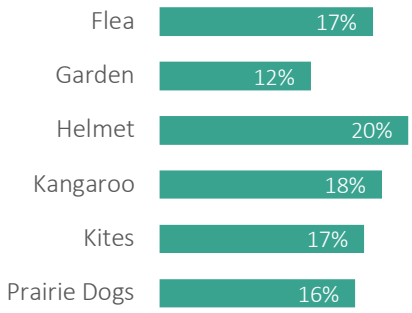


Figure 4. **Engineering Observations Collected, by Engineering Challenge** (n=139)



Pillar Observations - *Creatividad silvestre* contained four different areas with materials and interactives that were designed to introduce and reinforce the exhibit's main concepts for visitors, referred to as Pillar exhibits (see Table 1). The summative evaluation included observations in each of these four areas, to understand how deeply visitors engaged with the key content presented. Observers noted if visitors engaged briefly, engaged deeply (longer/more thoroughly), or did not engage at all with the elements in each Pillar.

Creatividad Silvestre
Engineering Design Challenges

"SALTA | JUMP" – Flea Activity

Visitors mimic how fleas store and release energy using a spring and adjust the angle of a launcher to land a ball on a cat, horse, and dog.

"REBOTA | BOUNCE" - Kangaroo Activity

Kangaroos bounce to gain energy. Visitors adjust the angle of trampolines and the drop height of a ball to see if they can hit the targets.

"ALIMENTA | FEED" – Bird Beaks Activity

Visitors complete three food gathering tasks by selecting the best form (bird beak style) for the function.

"VENTILA | VENTILATE" – Prairie Dog Activity

Visitors stack disks to change the height and shape of prairie dog mounts, in order to improve the circulation of air. A digital reader gives feedback on airflow.

"VUELA | FLY" – Kite Activity

Visitors design a kite and test its upward force in an air tube, in order to solve the challenge of charging a cell phone with wind energy.

"COLLABORA | COLLABORATE" – Rooftop Garden Activity

Visitors learn how certain plants benefit each other's growth in nature and then apply this principle to design urban gardens with high yields to feed a family.

"PROTEGE | PROTECT" – Helmet Activity

Visitors learn about different natural strategies that provide padding (like pomelo rinds) and then use simulated natural materials to create a helmet and test its ability to withstand impact.

At OMSI, these observations were also paired with a set of brief interview questions. When visitors appeared ready to leave the area, the data collector asked them questions designed to probe whether 1) the visitors perceived the main ideas presented in these exhibit elements, and 2) the visitors saw any relevance or connections between the content presented and their own lives or community. For the sake of time and to prioritize other data collection activities, these interview questions were eventually cut and are not reported here.

REFLEJA | REFLECT (Cooling Our Cities) activity in Biomimicry in Action Pillar

Table 1. **The Four Pillars of *Creatividad silvestre* and the Exhibit Themes They Support**

Pillar	Features/Themes
Entrance Pavilion	Introduces visitors to the concept of biomimicry with a definition and examples of biomimetic designs inspired by nature. The "Start Exploring" graphic wall introduces the concepts of function and strategy in nature, with light-up push buttons to invite interaction and exploration.
Workshop	Area with seating and rest space, as well as different hands-on activities to explore: • Lenticular folding activity – Activity developed for younger visitors where tilting folded paper back and forth reveals examples of biomimetic inspiration and design • "Do Biomimicry" – Paper activity that invites visitors to come up with their own biomimicry solution and sketch it out. • "Ask Nature" kiosk – Visitors explore webpages from the Biomimicry Institute that provide photo and text examples of function and strategy in a wide variety of organisms
Biomimicry in Action	Designing for Change video presents three real-world biomimetic designs that solve problems related to collecting water, reforesting, and cooling cities. Reading materials that support each of the examples from the video. Refleja | Reflect (Cooling Our Cities) includes a manipulative that lets visitors test how prisms can deflect light and heat.
Nature's Design Principles	Wall of flip panels that present "Seven Design Principles from Nature." These design principles are underlying principles of sustainable design and engineering. Examples include using shape to support function and using local, abundant resources. Designing with Nature video presents stories of four individuals who used biomimicry to solve a challenge in their community.

Figure 5. **Pillar Observations Collected, by Site** (n=102)

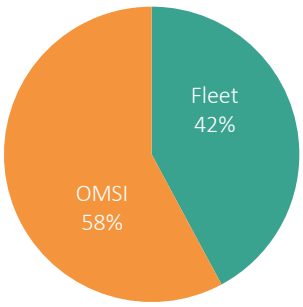
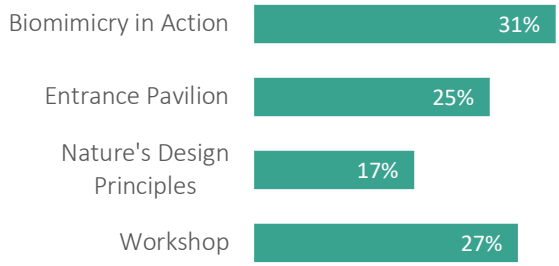


Figure 6. **Pillar Observations Collected, by Pillar** (n=102)



Analysis

Following each data collection cycle, researchers from OMSI met with a researcher from REA to reflect on the overall process, discuss what was working well or less well about the summative evaluation instruments, and capture contextual information that might be important for interpreting the data (for example, special events happening at the museums during data collection). Once data collection was complete at OMSI, an REA researcher conducted preliminary analyses, running descriptive statistics and rough coding on open-ended items. The team then met to discuss these findings before the next wave of data collection at Fleet Science Center. Once data collection at Fleet was done, the team met again to run through findings from one instrument at a time. All researchers reviewed open-ended responses from the interviews, and coding schemes were decided on collaboratively. An REA researcher then applied the coding schemes, after which OMSI team members reviewed the data once more to check for consensus. REA then ran descriptive statistics on all quantitative data collected. Certain demographic groups were separated from the sample to ensure that findings held up for these groups as well, including individuals in the target group and individuals of different races and ethnicities. This report presents findings for all three levels of target group priority together.

VISITOR ENGAGEMENT IN *CREATIVIDAD SILVESTRE*

VISITOR ENJOYMENT AND MAIN TAKE-AWAYS

Visitors' feedback in their exit surveys and interviews shows that *Creatividad silvestre* was a great success in engaging visitors. Survey respondents reported high enjoyment of the *Creatividad silvestre* exhibit, with the large majority rating the exhibit a 4 or 5 out of 5 stars (92%, n=84). Target group participants – those in the three priority groups described above (Target Audience, p. 12) - also gave the exhibit high scores.

Figure 7. **How much did you enjoy the exhibit?**
Average rating among survey takers

When asked what the exhibit was about or what OMSI was trying to teach in the exhibit, most interview participants talked about animals and/or nature (83%, n=113). The many natural world examples presented through *Creatividad silvestre* clearly stuck in participants' minds, and the name may have influenced their perception as well. Twenty-three percent of participants spoke specifically about strategies from nature – a more specific concept that the exhibit sought to teach. An equal number also mentioned humans learning from nature, showing that elements of the biomimicry theme were coming through for visitors as well. Fewer participants gave responses that referenced the themes of engineering or design (9% of interviewees).

Visitors test kite designs in an engineering challenge activity

Our family is having fun! I think you saw us really liking the helmets especially. So fun!

Table 2. **Visitors' Perceptions of *Creatividad silvestre* – Sample responses from exit interviews**

What would you tell someone this exhibit is about?
Creativity, wild animals in the wild, and other things in the wild
Different animals. But also, how we are improving tech and things just by studying them.
Es de la naturaleza y cómo trabaja el clima. [It's about nature and how climate works.]
New ways to learn about animals and the things they do
Having fun and learning about nature

Although engineering as a concept didn't immediately come to mind when visitors described the exhibit, the Engineering Challenges within the exhibit were the most popular elements of *Creatividad silvestre* – particularly the helmet, kangaroo, and kites activities. When asked to choose their favorite part of the exhibit, 95% of interview respondents chose one of the seven challenges (see Figure 8).

Furthermore, survey participants reported positive reactions to both the engineering content of the exhibit and the examples from nature. While it may not have been the first thing that came to mind when asked to describe the exhibit, most participants who completed the exit survey agreed or strongly agreed that *Creatividad silvestre* increased their interest in engineering (Figure 9).

Figure 8. **Interviewees' Favorite Exhibit Element**
(Exit survey, n=99)

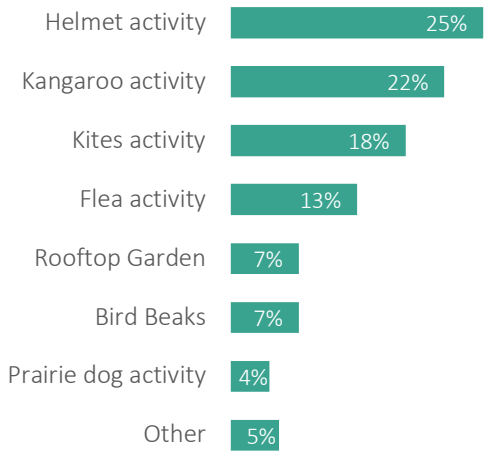
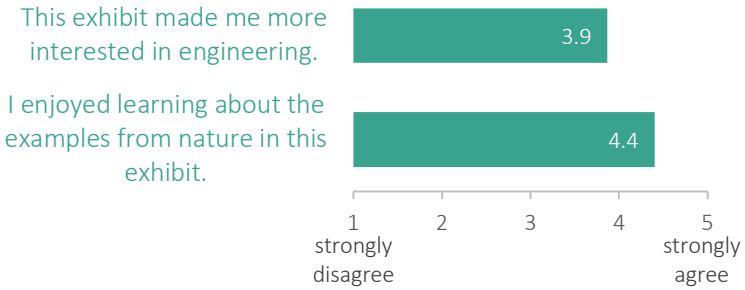


Figure 9. **Visitor Engagement with Key Themes**
(Exit survey, n=99)



OBSERVATIONS OF VISITOR ENGAGEMENT

Observation data from the Pillar exhibits and Engineering Challenges were also used to examine visitor engagement. Engagement at the Pillar exhibits was measured in terms of specific behaviors that were unique to that Pillar. Observers tracked how long visitors engaged with Pillar components and whether they read materials, watched videos, tried an activity, discussed the exhibit with their group, or displayed other behaviors indicating they were paying attention to the exhibit. (Exact behaviors tracked can be found in the observation sheets in Appendix: Instruments, p. 41.) Each observed participant was then given an engagement level of low, medium, or high for that Pillar based on their observed behaviors. Engagement level for the Engineering Challenges was coded based on basic behaviors that could be observed at any of the six challenges where data were collected. Criteria for assigning engagement scores for both the Pillars and Engineering Challenges can be found in the Appendix: Behavior Coding, p. 49.

Researchers found that most observed groups in *Creatividad silvestre* exhibited medium or high levels of engagement at both the Pillars and the Engineering Challenges. At a medium level, visitors were engaging in activities like reading or watching content at length (at least 20 seconds), completing a test of an Engineering Challenge, and discussing the exhibit content with members of their group. Children in the target group especially seemed to enjoy the Engineering Challenges. Sixty-seven percent exhibited high engagement levels (Figure 11).

Figure 11. **Observed Engagement at Pillar Exhibits** (n=102)

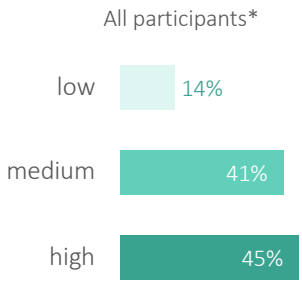
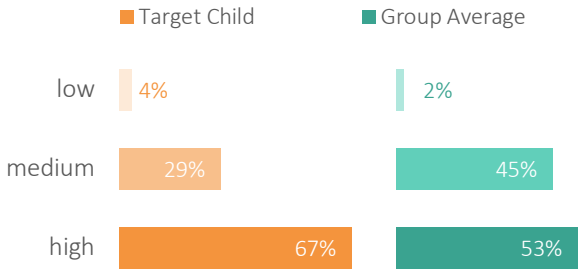


Figure 11. **Observed Engagement at Engineering Challenges** (n=141)



*Pillar observations did not record separate engagement levels for target individuals, so a group engagement score is reported here. However, almost all observed groups (99/102) included a target individual.

In terms of time, observation data shows that over half of visitors spent at least three minutes with the Pillar exhibits, and almost 70% spent three minutes or more at the Engineering Challenges. Some exhibit elements had fewer components to interact with – for example, the Entrance Pavilion and Nature's Design Principles. Nevertheless, data collectors noticed moments of high engagement at the Entrance, as adults paused to take in the purpose of the exhibit and then sometimes encouraged children to pause and take note as well. One researcher observed an intergenerational group talking about the Function/Strategy wall and putting it into terms the child would understand by talking about raincoats and the function they serve (exact metrics for each Pillar can be found in Appendix, p. 47). The Engineering Challenges were very popular with visitors. Fifty-seven percent of the groups observed completed the challenge they were engage with at least one time, and another 32% completed the challenge multiple times.

Figure 12. **Visitor Time at Pillar Exhibits**
(n=90)

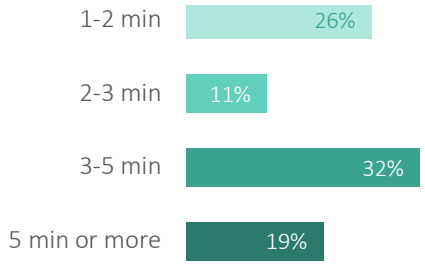
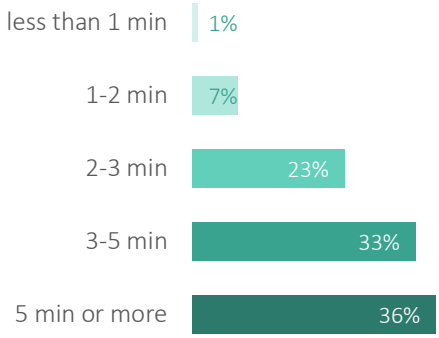


Figure 13. **Visitor Time at Engineering Challenges**
(n=132)



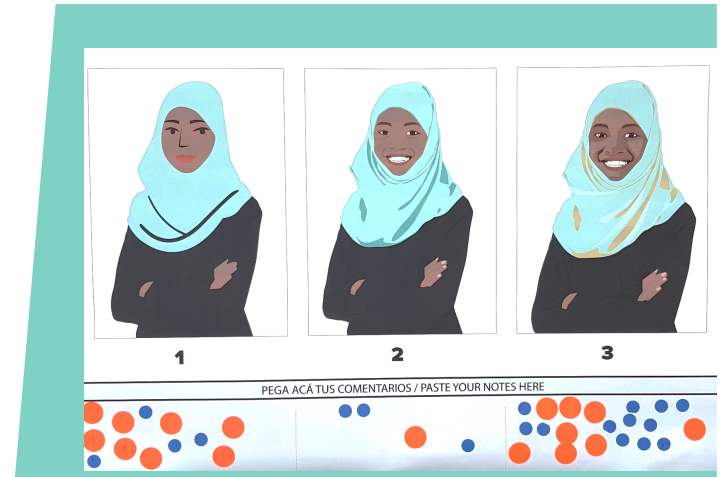
According to the observation data, the most engaging part of the Pillar exhibits was the Refleja | Reflect component, which offered reading materials on this real-world biomimicry solution, as well as a hands-on manipulative that visitors could try. Many visitors also paused to engage longer with the Entrance Pavilion graphics and the push-buttons on the Function/Strategy wall, which may have helped to relay some of the core messages of *Creatividad silvestre*. In contrast, observers noticed that the videos presented in the exhibit – "Designing with Nature" and "Designing for Change" – often received lower engagement, possibly because of the competing noise level of the exhibit.

CULTURAL AND PERSONAL RELEVANCE OF *CREATIVIDAD SILVESTRE*

An important goal for the Designing Our Tomorrow project has been to shine a light on diversity in engineering and ensure that audiences can find personal relevance in the content and messages that OMSI is presenting. Throughout the project, the OMSI team continually sought the feedback and expertise of community members – particularly girls aged 9-14 and their families – to inform decisions surrounding the C-PIECE Framework and the design of *Creatividad silvestre*. Feedback from visitors, community groups, and advisors was all considered when making decisions about the exhibit design, language and vocabulary, and the examples used to illustrate key ideas.

While almost all elements of *Creatividad silvestre* have been touched by this co-development process, measuring the cumulative impact of these many – often subtle – decisions is not straightforward. *Creatividad silvestre* asserts its cultural relevance

through imagery, language, and narratives, but without directly calling attention to it – so did visitors notice? To understand the extent to which this intentional process influenced the visitor experience and outcomes, the summative evaluation included a variety of questions in the exit interview and survey to get at the themes of personal and cultural relevance.

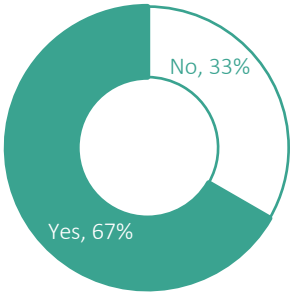


Sticky dot polling to inform exhibit imagery during formative evaluation

When asked if any parts of *Creatividad silvestre* made them think about their own lives or communities, 67% of interview participants responded, "yes." Participants were then asked to elaborate. While many of their answers described general familiarity with features of the activities (e.g., "I wear a helmet when I ride my bike."), others show that the exhibit struck a deeper chord with some visitors, making them think about how the exhibit's core themes are interwoven with important realities in their own lives and communities.

Figure 14. **Responses from Exit Survey on Personal Relevance** (n=111)

Did any parts of this exhibit make you think about your own life or community?



Sí, la actividad de las milpas especialmente porque mi esposo se dedica a eso. [Yes, the activity of the cornfields especially because my husband is dedicated to that.]

The prism activity reminded me of science class, studying reflection. Also, global warming.

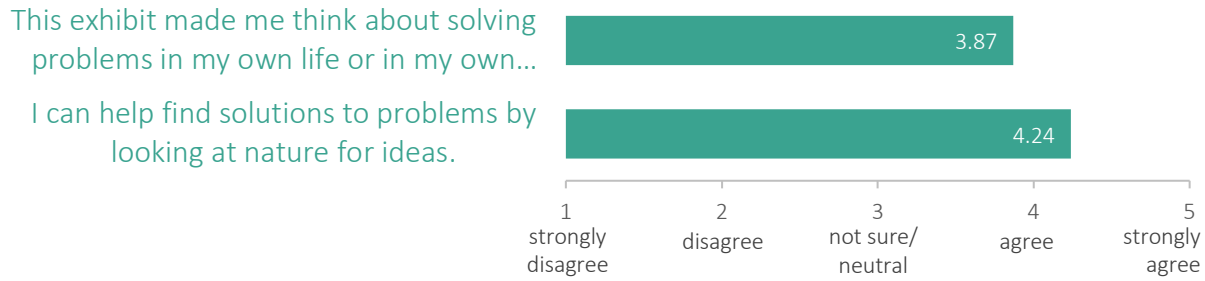
The kites - We fly a lot of kites in the summer at the beach.

We're from Austin, TX where it's hot! So seeing the prisms was cool. Learning how new methods of cooling a city can work really well.

One visitor quoted above spoke about the Refleja | Reflect exhibit and how this reminded them of soaring temperatures in their own city. Several other visitors talked to the data collection team about conserving water (referenced in the "Collecting Water" exhibit) and how this is an important issue where they live as well. In moments like this, *Creatividad silvestre* succeeded in demonstrating the importance of biomimicry to an individual's lived experience. Even the lighter examples given by participants, such as the reference to kites, show that the exhibit presented content that was familiar and accessible.

In fact, during the follow-up tablet survey, 65% percent of respondents agreed or strongly agreed that they were already thinking about solving problems in their own lives or communities (Figure 15). Even more participants agreed or strongly agreed that they could find solutions to problems by looking at nature for ideas (83%, n=99). Very few participants expressed outright disagreement with these statements (8% and 5%, respectively).

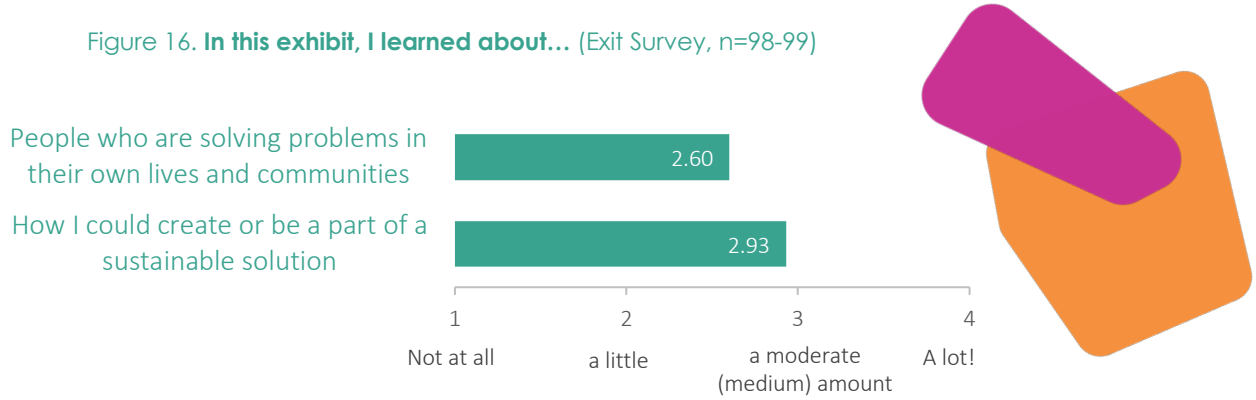
Figure 15. **Personal Connections to Exhibit**
(Average Scores from Exit Survey, n=99)



While the exhibit started the wheels turning for many visitors on how they might solve problems in their own lives or communities, participants gave more moderate ratings on survey questions that asked if the exhibit had specifically taught them about this (Figure 16). One of the features of *Creatividad silvestre* is a set of "call to action" panels that invite visitors to continue engaging in engineering practices and thinking about biomimicry, nature, and sustainability beyond their museum visit. The panels gave examples of how visitors can be involved and were designed to be customized by the host site, with examples that are locally relevant. They also included a QR code that takes visitors to a website with activity sheets hosted by the Biomimicry Institute. These panels were not interactive, however, and may have escaped notice of many visitors.

More surprising is the lower rating that participants gave to the survey statement, "In this exhibit, I learned about people who are solving problems in their own lives and communities." (also Figure 16). *Creatividad silvestre* contains many examples of real individuals who are devising sustainable solutions – for example, in the "Designing with Nature" video, and in each component of the Biomimicry in Action Pillar. These components, however, didn't often rate as participants' favorite (see Figure 8, p. 19), and might not have made as big an impression on visitors.

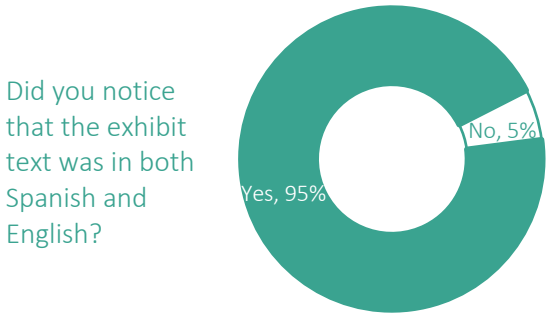
Figure 16. **In this exhibit, I learned about…** (Exit Survey, n=98-99)



One of the most obvious ways that OMSI sought to make *Creatividad silvestre* culturally relevant for members of Latino communities was to present all exhibit content in both Spanish and English. While the OMSI team takes care to stress that providing text in two languages only scratches the surface of culturally responsive practice, this is one element of *Creatividad silvestre* that almost all visitors noticed.

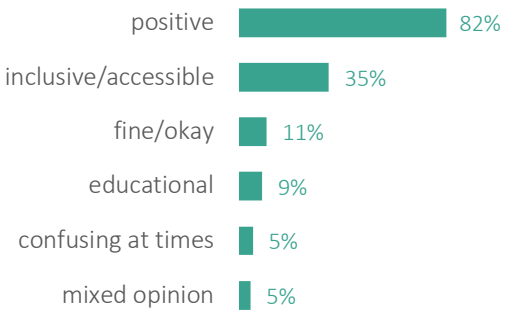
Function/Strategy exhibit panel

Figure 17. **Awareness of Bilingual Presentation**
(Exit interviews, n=110)



When asked what they thought about the inclusion of the Spanish text, a strong majority of interview participants had a positive reaction (Figure 18). Many participants talked about the inclusion of Spanish as being inclusive to other people's cultures or as making the exhibit more accessible to diverse audiences. Some people also talked about the educational value of having the exhibit presented bilingually since many people are trying to learn Spanish. A few individuals said seeing Spanish presented first caused them some confusion, but they usually went on to say that they liked it. Roughly 11% of visitors made neutral comments, not expressing any like or dislike. No one made overtly negative remarks.

Figure 18. **Reactions to Spanish Text in Exhibit**
(Most common themes from exit interview responses, n=110)



Example Comments

Great! threw us off a little at first with order but otherwise good.

Muy, muy bien. Aunque tenemos muchos años aquí, no dominamos el inglés, así que nos da gusto, y orgullo. [Very, very good. Although we have been here for many years, we haven't mastered English, so we like it, and it makes us proud.]

Cool. I want to speak Spanish. I liked that it was first.

Two languages are great to know because it is part of other people's life and language.

The final way the summative evaluation examined the cultural relevance of *Creatividad silvestre* was to look for any significant differences in survey respondents based on their age, gender, and race/ethnicity. It was particularly important that the exhibit's main target audience of girls ages 9-14 expressed positive outcomes, as well as those with Hispanic heritage. Analyses of the survey data showed that diverse participants responded similarly to the exhibit, with no significant differences based on demographics to questions that addressed learning, the relevance of the exhibit to individuals' lives, or the impact of the exhibit on their interest in the content presented.

VISITOR APPROACHES TO ENGINEERING CHALLENGES

DEMONSTRATING ENGINEERING PRACTICES

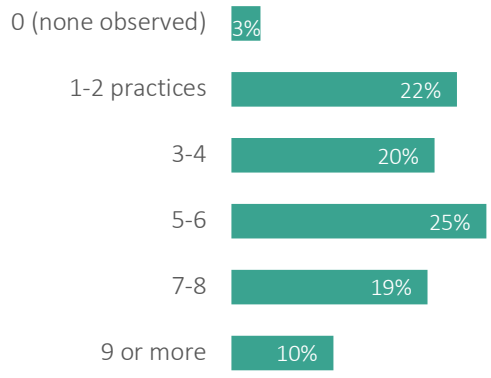
The individual exhibits in *Creatividad silvestre* were co-developed after extensive initial research. The OMSI team conducted a literature review of previous studies and models used to describe engineering skills, and developed and tested the C-PIECE Framework and supporting data collection instruments with family audiences. These efforts eventually led to the design of the Engineering Challenges in *Creatividad silvestre*, as well as the Design Challenge Resource Collection which serves as a guide to informal science professionals on what characteristics make an impactful and engaging engineering challenge for museum visitors. After developing and testing an observation instrument during the formative and remedial stages of the project, the OMSI team employed the instrument in the summative evaluation to investigate if the final exhibits in *Creatividad silvestre* succeed in supporting the engineering proficiencies incorporated from the C-PIECE Framework.

The C-PIECE Framework divides 37 engineering practices into two categories of proficiencies (*Defining a Problem*, and *Improving a Design*), and three levels for each proficiency (Beginning, Intermediate, and Informed). Beginning level practices include things like attempting an engineering challenge without seeking information first (e.g., without reading instructions or watching others attempt the challenge) and making adjustments to a design at random (as opposed to having a specific intent). Here we only report on practices in the intermediate and informed proficiency levels. There are 30 of these practices in total in the C-PIECE Framework, 20 of which were observable and included in the observation instrument.

Data collectors observed 139 different groups across six different Engineering Challenges. Most of these groups (62%) consisted of 2-3 people, and most spent at least three minutes engaging with the activity (70%). Almost all (96%) included individuals in the priority target groups. Observations of these visitor groups showed that 55% engaged in at least five engineering practices at the intermediate or informed level.

20	Total # of different intermediate + informed engineering practices tracked
4.9	Average # observed per group
5	Median # observed per group
11	Maximum # observed in any single group

Figure 19. **Count of Engineering Practices Observed per Group at the Intermediate or Informed Level** (n=139)



Engineering Practices at the Intermediate and Informed Levels

Not only did most groups engage in five or more engineering practices, most groups were not engaging solely at the intermediate level or solely at the informed level. Instead, 73% of groups displayed a mix of practices across these levels. Forty-nine percent of the observed groups displayed three or more intermediate practices, and an even higher percentage displayed three or more informed practices (Figure 21).

Figure 20. **Average # of Engineering Practices Observed Per Group – By Proficiency Level**
(n=139)

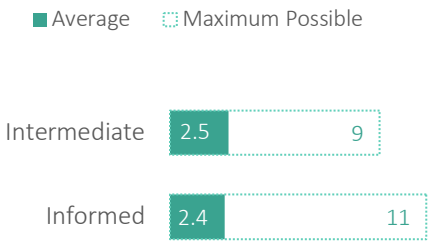
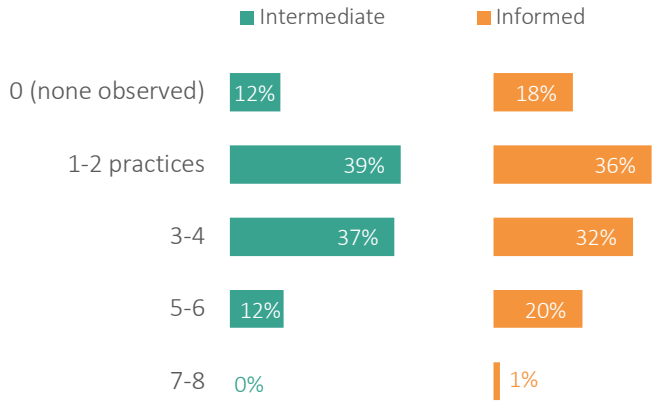


Figure 21. **Count of Engineering Practices Observed Per Group – By Proficiency Level**
(n=139)

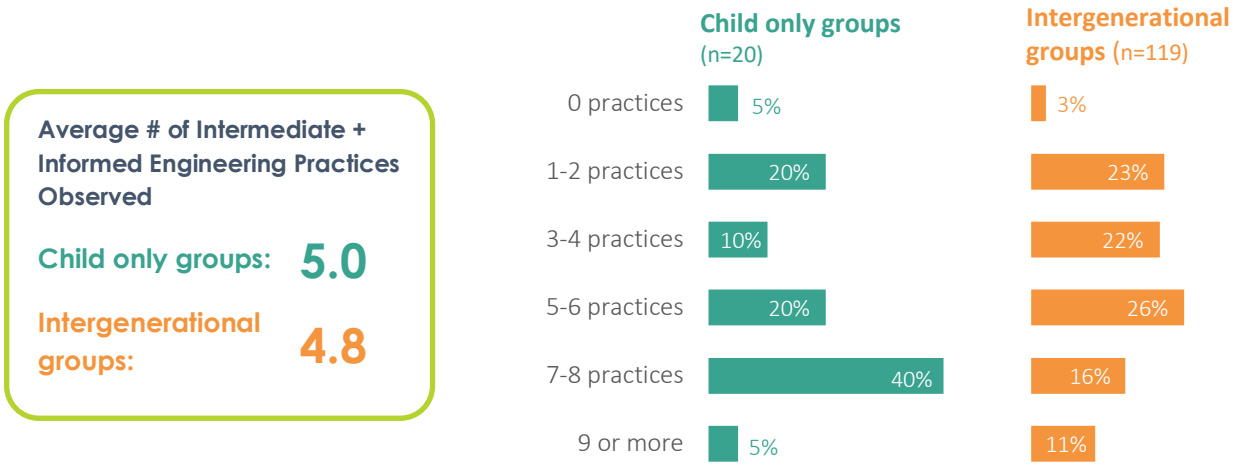


Influence of Adults

Most of the groups observed by researchers contained a mix of children and adults, but 20 groups (14% of the sample) had only children. While the sample size for this sub-group is quite small, it is interesting to note that the number of intermediate + informed engineering practices they displayed was not much different from groups that contained a mix of children and adults (See Figure 22). In fact, one of the child-only groups exhibited nine different practices while engaging with the Flea challenge. This was a group of three individuals between roughly the ages of 11 and 13 who were engaged with the Flea challenge. On the other hand, data on child/adult collaboration suggests there may be certain practices that are more likely to emerge when a child is accompanied by an adult (see Collaboration and Problem-Solving, p. 31 below).

Two visitors work on the kite engineering challenge

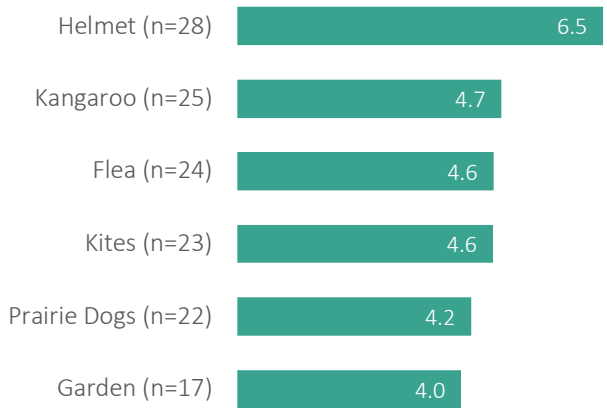
Figure 22. **Averages and Counts of Engineering Practices Observed Per Group – By Group Type**



Differences Between Engineering Challenges

Of the different Engineering Challenges, all showed potential for eliciting engineering practices from visitors. The average number of intermediate + informed practices observed for a group at each exhibit was at least four. The Helmet activity appears to have been most successful in prompting visitors to engage in these practices, with groups averaging 6.5 practices – slightly more than the average at any of the other Engineering Challenges. Again, sample sizes of observations for each individual Engineering Challenge are small, but it may be that this exhibit – through its presentation, its content matter, or some other factor – encouraged visitors to think more deeply about how they approached the challenge.

Figure 23. **Average # of Engineering Practices Observed Per Group – By Engineering Challenge**



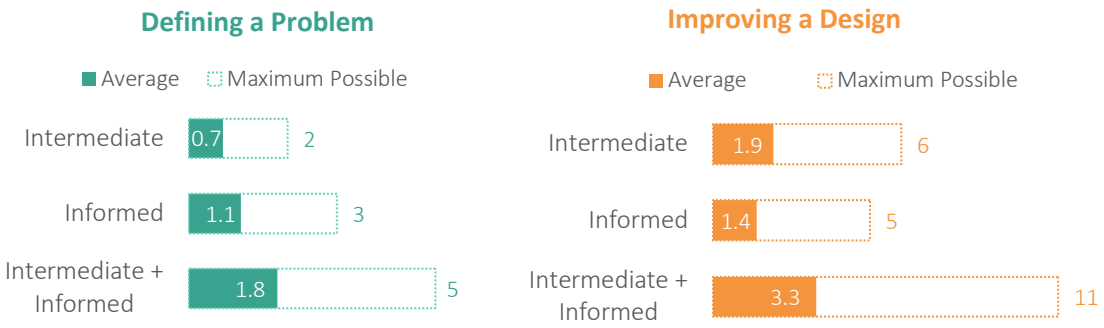
It is important to note that observations are likely to undercount the number of engineering practices that any individual or group engaged in, since observers cannot always hear what

visitors are saying or observe every single individual when paying attention to a group. The researchers who collected data for the *Creatividad silvestre* summative evaluation noted any instance when they observed a particular behavior or heard a conversation that aligned with practices in the C-PIECE Framework, but many times sections within the observation sheet had to be left blank if the observer had missed that particular category of evidence. Furthermore, some of the engineering practices in the framework were left out of the observation protocol for being impractical to identify by observation alone (e.g., "focuses on problematic subsystems"). The values represented here therefore should be considered conservative estimates of the engineering practices that *Creatividad silvestre* visitors engaged in.

Defining a Problem & Improving a Design

In addition to engineering practices at different levels of skill, the research team was interested to know if observed groups also used practices within the two proficiencies of the C-PIECE Framework (Defining a Problem and Improving a Design). In other words, the research team wanted to know if visitors used intermediate and informed level practices in different stages of the Engineering Challenges presented – for example, both brainstorming initial ideas and later testing specific variables. Observation data confirms they did. On average, visitor groups used 1-2 practices within the Defining a Problem proficiency, and 3-4 practices within the Improving a Design proficiency (see Figure 24).

Figure 24. **Average Number of Intermediate and Informed Engineering Practices Observed Per Group – Proficiency** (n=139)



Some of the engineering practices the groups were observed using most often as they defined the problem were stating a goal and considering the benefits and trade-offs of materials - 34-35% of observed groups (Table 3). Even more groups prematurely attempted the challenge – meaning they took in one source of information before making their attempt. This might be reading or listening to information provided, exploring resources available, or watching others who were engaging with the challenge. Only 18% of observed groups engaged in more than one of these activities. During observations, data collectors noticed many children would watch their siblings, a child from another group, or a parent before making their own attempt. At the helmet activity, visitors were often observed handling the different materials to see what was available (exploring resources). Across activities, parents or older siblings were often observed reading instructions to younger members of the group (more on reading below, under Collaboration and Problem-Solving, p. 31)

Table 3. **Counts of Individual Engineering Practices Observed in Groups at Engineering Challenges** (n=139)

	Practice	Count of Groups Observed Using this Practice	Level
Defining a Problem	Brainstorms - initial design	24	intermediate
	Goal articulation - identifies/describes criteria or constraints	11	informed
	Goal articulation - states a goal	47	informed
	Relates content to prior experience	25	informed
	Considers benefits and trade-offs of materials:	49	informed
	Prematurely attempts challenge	61	intermediate
	Delays design decisions	25	informed
	Reads or listens to information provided	99	intermediate
	Explores resources	110	intermediate
	Watches others	66	intermediate
Improving a Design	Testing - multiple tests (repeated tests of same design)	51	intermediate
	Testing - continued testing (successful test, followed by modifications and retesting)	36	informed
	Testing - adjusts testing conditions	56	intermediate
	Interprets results - identifies pros/cons of design	10	intermediate
	Interprets results - diagnoses issues	27	intermediate
	Interprets results - describes what happened	43	intermediate
	Interprets results - explains result	15	informed
	Goal assessment - qualitatively	27	intermediate
	Goal assessment - quantitatively	34	informed
	Goal assessment - compares to past performance	3	informed
	Brainstorms - improvements	56	informed
	Applies modifications - directed	51	intermediate
	Applies modifications - completes multiple iterations (repeating the cycle of build, test, improve)	25	informed

Under the second engineering proficiency, Improving a Design, the most frequently observed practices were conducting multiple tests (repeated tests of the same design), brainstorming improvements, and applying directed modifications (purposeful changes to improve performance). This shows that visitors were not only completing the challenge, but were compelled to make changes and try again to see if they could get a better result. For example, one child at the Kangaroo challenge was overheard saying, "If I pull it like that or apply more pressure, it might work better. That's my process." This conversation overheard at the Helmet challenge also shows visitors brainstorming, as well as testing specific variables:

Should we use something to disperse [impact]?

We're gonna want to use a cushion.

What if we put the cushion on the outside?

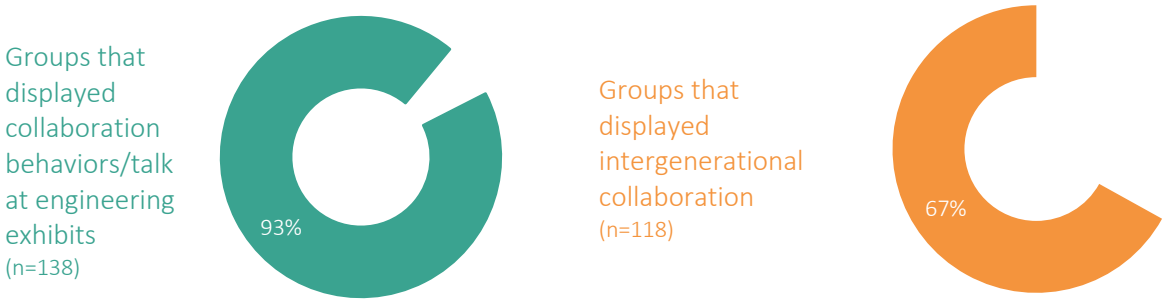
What if we take out one?

A large number of visitor groups were also observed adjusting testing conditions, for example, dropping a ball from the top instead of the bottom at the Kangaroo activity or resting their kite on the fan versus holding it in the flow of air at the Kite activity.

COLLABORATION AND PROBLEM-SOLVING

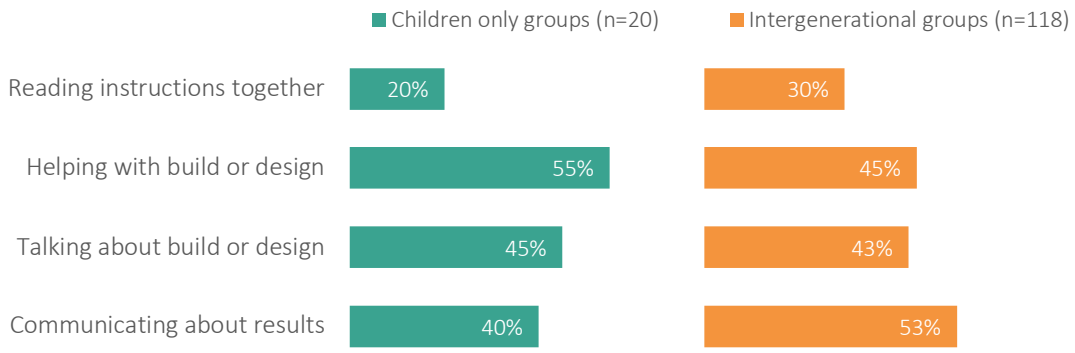
In addition to supporting visitors' individual development of engineering proficiencies, *Creatividad silvestre* was also designed as a family-friendly experience that encourages groups to collaborate together as they work through the challenges. All but two of the 140 groups observed at the Engineering Challenges consisted of more than one individual and therefore had the opportunity to work together. Of these groups, 93% engaged in at least one collaborative behavior. Most of the observed groups (84%, n=140) also consisted of individuals from different generations – for example, children and their parents. Of these groups, 67% engaged in some form of intergenerational behavior. The large difference in these percentages is somewhat difficult to interpret, but some notes from the observations suggest that adults in groups with multiple children sometimes stepped back from the activity and let children take the lead. Observers also noted instances of parallel play – where both the adult and child worked independently on the challenge without collaborating. And as often is the case in museums, there were also instances of adults using their cell phones or chatting with other adults while their children engaged with the exhibit.

Figure 25. **Prevalence of Collaborative Behaviors at Engineering Challenges**



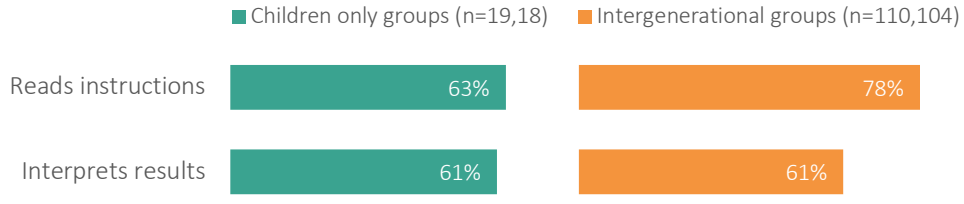
Observers tracked four different types of collaboration while collecting data on the Engineering Challenges: visitors reading instructions together, helping one another with a build or design, talking about their build or design, or communicating about the results of a test. The kinds of collaborative behavior and talk observed in the various groups at the Engineering Challenges was fairly similar between intergenerational groups and those that consisted of only children (Figure 26). (None of the observed groups consisted of only adults.)

Figure 26. **Prevalence of Different Collaborative Behaviors – Children Only Groups and Intergenerational Groups**



Some of the small differences between these different group types are intriguing, however. The children-only groups, for example, were less likely to read instructions together in a collaborative manner. Children-only groups were also less likely to read the instructions at all, in comparison to groups with both children and adults present (Figure 27). This may mean that reading instructions is one area where adults tend to drive collaborative behavior and can support children in developing engineering proficiencies – e.g., delaying design decisions until after gathering information about the challenge. Other engineering practices may be more intuitive to children. For example, even though the members of children-only groups communicated amongst themselves about test results less often than when there was an adult present (40% versus 53%, see Figure 26 above), both types of groups were observed interpreting results in the same frequency (Figure 27). The sample size for children-only groups in the observation data is too small to be conclusive about the differences in collaboration behaviors and engineering practices, but they point to intriguing areas for future research.

Figure 27. **Prevalence of Different Engineering Practices – Breakout by Group Type**



VISITOR AWARENESS, UNDERSTANDING, & CONFIDENCE

IMPACTS SURROUNDING ENGINEERING PRACTICES

Engineering examples and activities were infused throughout *Creatividad silvestre*, but as noted above (Main Takeaways, p. 4), many visitors did not talk about engineering or humans designing solutions to problems when they were asked what the exhibit was about. Instead, their answers often focused on the natural world and animal examples. During data analysis meetings, the research team discussed this finding and what it might mean. While engineering was an important theme of the exhibit, the word "engineering" did not actually appear many times in the signage, and visitors may have been less likely to make the connection without direct prompting - e.g., "Try your engineering skills!" During discussions with community advisors, one participant also noted the word "engineering" tends to evoke a feeling of complexity, but not necessarily fun, for most audiences.

Additionally, many of the Engineering Challenges in the exhibit present animal examples (in order to illustrate the theme of biomimicry). This may be another reason that visitors did not initially talk about engineering or solving human problems in their interview responses. Nevertheless, the Kite, Garden, and Helmet challenges all represent humans finding solutions to real-world problems by taking inspiration from nature, and the various animal examples provided might also have prompted visitors to think about challenges and solutions in their own lives. The small number of individuals who did talk about engineering, design, or creativity in their exit interviews (8.6%, n=116) shows that *Creatividad silvestre* did spark these connections for some:

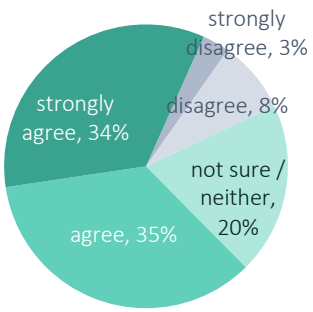
> ***What would you tell someone this exhibit is about?***
>
> *Animals and nature, and how their physical traits can teach us how to get creative with inventions.*
>
> *I think the goal is to teach children to problem solve and engineer and show how to involve it in their lives.*

Even though most participants did not mention engineering in their initial descriptions of the exhibit, their survey responses show that a large percentage were making the connection. Sixty-nine percent of survey respondents agreed or strongly agreed with the statement, "In this exhibit, I felt like I was doing things an engineer would do."

Survey responses also showed that the Engineering Challenges were presented at an appropriate level for more visitors to feel they

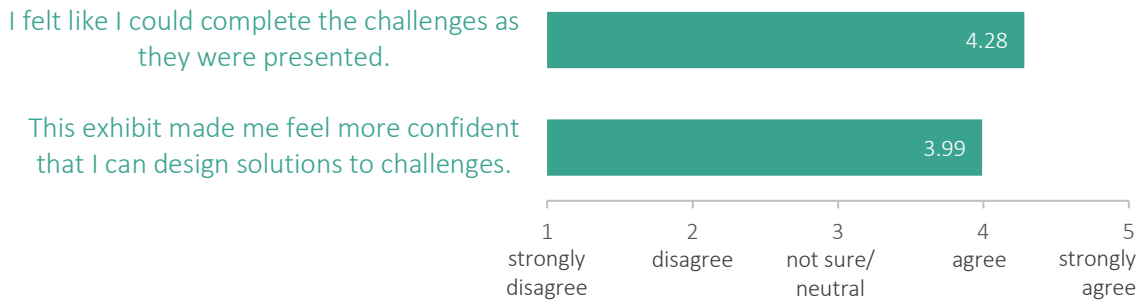
Figure 28. **Doing things an engineer would do**
(Exit survey, n=97)

In this exhibit, I felt like I was doing things an engineer would do.



could be successful. Eighty-seven percent of survey respondents agreed/strongly agreed that they could complete the challenges. Visitors were less likely to transfer that sense of engineering efficacy to solving problems in other contexts, however. Sixty-nine percent agreed/strongly agreed that *Creatividad silvestre* had made them feel more confident about designing solutions to challenges.

Figure 29. **Visitors' Engineering Confidence and Self-Efficacy** (Exit survey, n=97)



Previous research has shown that museum visitors who have engaged with an engineering challenge activity tend not to describe their actions or thinking as "engineering," and although they may use a number of different engineering skills, they often do not describe their actions as such.[5] The data collected during the summative evaluation of *Creatividad silvestre* provides further evidence of this phenomenon. In the exit interviews conducted, researchers asked participants to describe one of the Engineering Challenges they had done and the steps they had taken, but the word "engineering" was not used in the prompt. Instead, researchers asked, "Can you tell me about this hands-on activity you did? What steps did you take to solve this challenge?" Of the 100 responses collected, only one visitor used the word "engineering." The remainder primarily described their actions in very general terms (e.g., "tried something to see if it worked," "tried to get the ball in the hole").

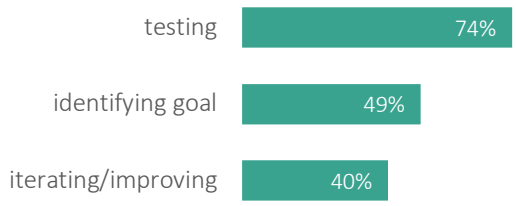
While visitors didn't use terms like "iteration" or "diagnosing issues," observations had shown that many individuals did engage in engineering practices (on average, roughly five intermediate and informed practices per group) at the Engineering Challenges. After reviewing the list of responses and looking for common themes, the research team found that many responses could be tied to three broad engineering practices within the C-PIECE Framework: identifying a goal, testing, and iteration/improvement. Explanations of these codes and example responses representing each are presented in Table 4.

[5] Randol, S. M., & Herran, C., & Ramos-Montanez, S., & Shagott, T., & Benne, M. R. (2021, July), Engineering Awareness at Design Challenge Exhibits (Fundamental) Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. 10.18260/1-2--37052

Table 4. Coding of engineering practice question (Exit interview, n=100)
Can you tell me about this hands-on activity you did? What steps did you take to solve this challenge?

Response Codes	Example Responses
Identify Goal – describing the objective of the challenge	*Make a kite, hang it on. And it blows air and charges a phone.* *My mom helped me bounce the ball to get it into the hole, and get a high score.*
Testing – making an attempt and observing the results	*A lot of trial and error, kept trying* *Bounced the ball and moved the things to help it to bounce.*
Iteration or Improvement – modifying an initial design or attempt based on feedback	*Just stack everything. The more I stack, the healthier the prairie dogs are. Trying to stack more rings.* *Put the parachute on the thing and pushed the button. tried different parachutes until we found one that worked good.*

Figure 30. **Presence of Engineering Practices in Interviewees' Open-Ended Responses** (n=100)



Participants' coded responses referred to testing 74% of the time. Almost half of participants described the goal of the activity, and 40% described actions that involved improving upon their initial design or attempt. These responses, along with the observation data, show that *Creatividad silvestre* visitors were most certainly employing engineering practices to solve the challenges presented, but most do not think of their actions as engineering-related without prompting.

IMPACTS SURROUNDING BIOMIMICRY AND SUSTAINABLE DESIGN

Judging by visitors' descriptions of *Creatividad silvestre*, the animal and nature examples present throughout the exhibit made a strong impression. When asked to describe what *Creatividad silvestre* was about, these examples frequently popped up in participants' answers. Many participants referenced specific Engineering Challenges, for example, "animals and different beaks and feathers to fly" – a reference to the bird beaks and kites activities. Others made

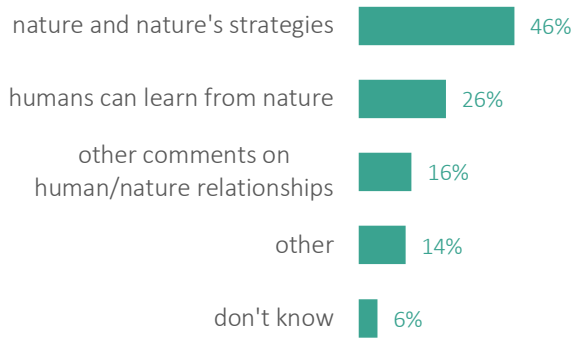
general comments about animals and nature, such as "new ways to learn about animals and the things they do." Just as the research team probed visitors' understanding of their engineering practices without directly referencing "engineering," the team also wanted to know if visitors absorbed ideas about biomimicry without specifically using that word. In terms of the exhibit's goals, it was more important that visitors develop an understanding of biomimicry as a concept than that they recognize and use the term "biomimicry." In exit interviews, data collectors therefore said to participants, "This exhibit uses a lot of examples from nature. What do you think these examples are trying to show?" The most common themes in participants' responses are shown below (Table 5).

Table 5. Coding of Nature's Examples Question (Exit interviews)
This exhibit uses a lot of examples from nature. What do you think these examples are trying to show?

Response Codes	**Explanation of Code** *Example Responses*
Teaching about nature and nature's strategies	These participants understood *Creatividad silvestre* was conveying information about animals and nature. They sometimes specifically mentioned nature's strategies and functions (though not necessarily using these terms): *How nature works. How animals do stuff.* *Different animals and how they interact and what we are able to learn about them.*
How humans can learn from nature	These participants made comments related to biomimicry, though not specifically using that term: *Ways we can learn from it, and things that can be invented.* *How you can make things using nature as a guide.*
Other human/ nature relationships	These participants talked about relationships between humans and nature that weren't related to biomimicry. They often referenced sustainability: *La importancia de la naturaleza. [The importance of nature.]* *That we can learn how to treat the earth better by seeing what nature does.*

A large proportion of respondents – 46% - said the examples were intended to teach about nature and nature's strategies, which aligns with one of the exhibit goals. Throughout the exhibit, the signage and activities highlight the strategies that nature has developed to overcome challenges. This is perhaps the first step in the ladder to thinking about biomimicry – recognizing that nature has clever solutions and paying attention to how plants and animals tackle challenges in their environments.

Figure 31. **Visitors Perception of Nature Examples in Exhibit**
(Coded responses from exit interviews, n=109)



The next step in the ladder is considering that some of these solutions from nature might also have applications to human problems. Twenty-six percent of visitors made this connection – achieving another key learning goal for *Creatividad silvestre*. These visitors gave responses like:

This exhibit uses a lot of examples from nature. What do you think these examples are trying to show?

Probably how to use nature to inspire our society to create things.

Ways that what they do [what nature does] can be useful for us to create new things or new ways to see the world.

How we can design using ideas from nature.

Creatividad silvestre provided many ways for visitors to make these connections between nature's strategies and human engineering problems. Each Engineering Challenge, for example, was accompanied by a panel presenting the story of a person with a real challenge that could potentially be solved through the activity – for example, bike helmets that could incorporate natural strategies into their design, as shown in the image at right. As is often the case in interactive exhibits, however, children and others approaching the Engineering Challenges may not have noticed this additional contextual information, instead focusing on just the information they needed to complete the activity.

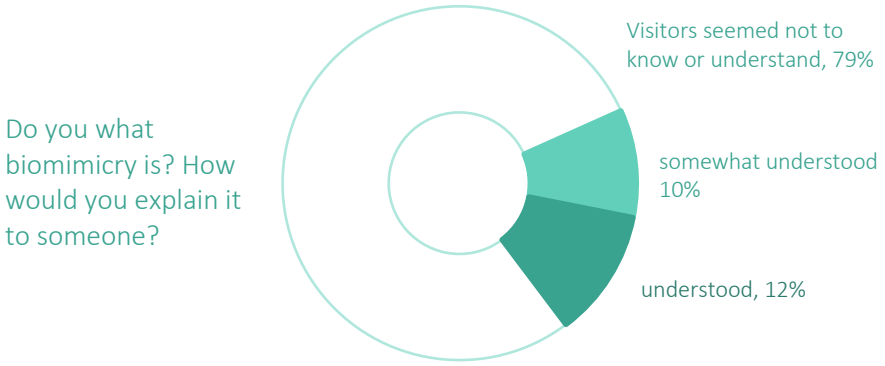
Helmet Engineering Challenge, with real world application circled

The exhibit also provided many more didactic examples of biomimicry – for example, through the "Designing with Nature" video that highlights the accomplishments of four individuals who used biomimicry to solve problems in their lives and communities. As noted above (Observations of Visitor Engagement, p. 20), visitors tended not to spend long watching this video, which may have made it more difficult for the theme of biomimicry to permeate into the visitor experience.

Nevertheless, exit interviews showed that 22% of participants did in fact have some familiarity with the term "biomimicry" by the end of their visit. Visitors were asked to define biomimicry later in their interview, after they had the opportunity to answer the previous question about nature's examples. As the research team suspected, even though some participants appeared to have learned about biomimicry concepts from *Creatividad silvestre*, describing it in their responses, fewer were able to define the word when asked directly (Figure 32). Twelve percent did

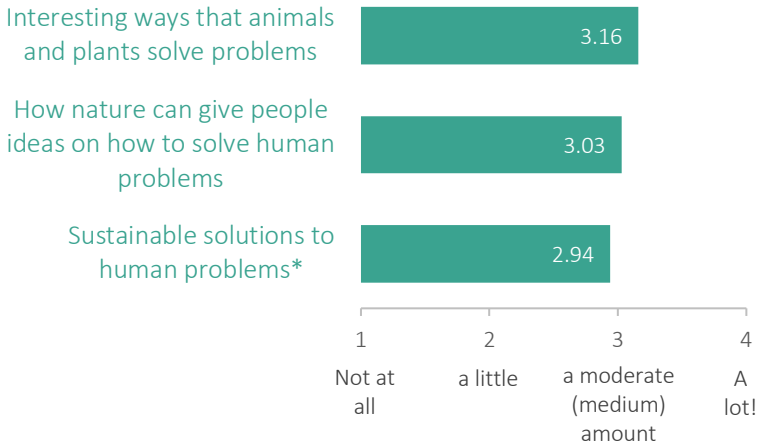
understand the term and described it successfully. They gave responses such as "interventions and innovations based on nature" and "How nature can be a guide to inventing new stuff." Another 10% gave answers that were on the right track, but didn't indicate their understanding as clearly, such as, "what the natural world is trying to show us," or "integrar la naturaleza en el dia a dia" (integrating nature in our day-to-day lives).

Figure 32. **Visitors' Descriptions of "Biomimicry"**
(Coded responses from exit interviews, n=112)



While visitors might have had some difficulty describing biomimicry in their own words, their survey responses completed just after the interviews suggest that OMSI's awareness and learning goals surrounding these themes were achieved for many. On average, visitors said they learned a moderate amount about strategies from nature (interesting ways that animals and plants solve problems), about how people can get ideas from nature to solve their own problems, and about sustainable solutions as well (Figure 33).

Figure 33. **In this exhibit, I learned about…**
(Exit survey, n=98-99)



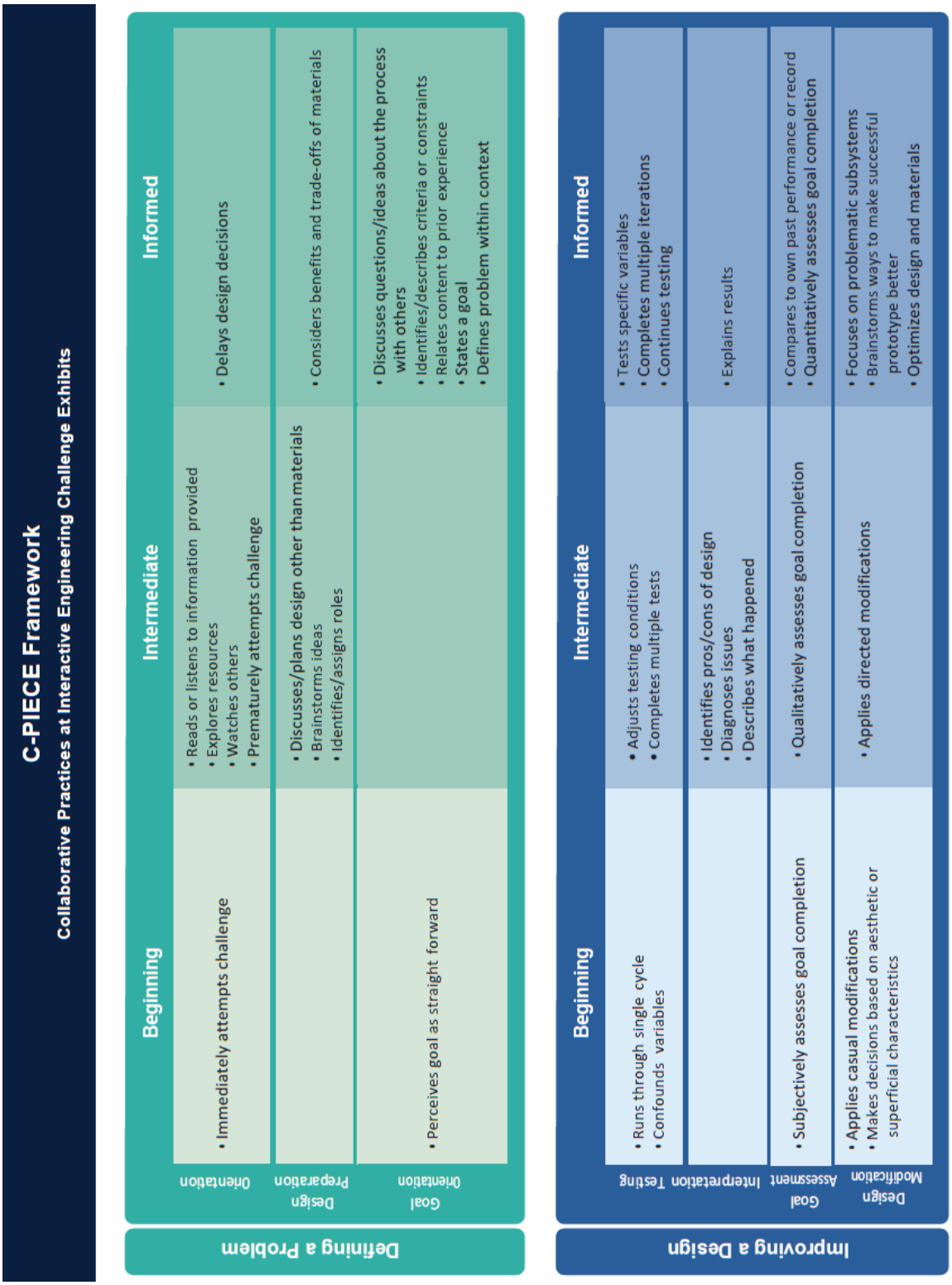
* In the survey, this item was presented as, "Sustainable solutions to human problems (solutions that are good for us AND for nature)."

CONCLUSION

Creatividad silvestre has made important new contributions to the field of informal science education and understandings of how to engage families in engineering design challenges. As a testing ground for the C-PIECE Framework, the exhibit shows how children and their families will demonstrate a range of engineering practices at the intermediate and informed levels when exhibit activities are carefully designed to support these. The summative evaluation also underlined the success of the co-development approach employed by the OMSI team, to create an exhibit full of imagery, language, and examples that resonate with different communities. While some of the content from *Creatividad silvestre* – like the word "biomimicry" – may not have sunk in for all visitors, visitors reported other positive outcomes related to learning from nature. The exhibit weaves many rich topics together – engineering, biomimicry, individuals solving community problems, and designing for sustainability. Overall, visitors walked away thinking about many of these, while also having a positive and fun experience – a success for any exhibit.

APPENDIX

C-PIECE FRAMEWORK



INSTRUMENTS

Creatividad silvestre Exit Interview

Recruiting Priority: 1) girls 9-14 2) girls 6-16 3) children 9-14

Date/Time: _____ **Data Collector:** _____ **Group #:** _____

Recruitment Script: Hi, my name is ___ and I'm collecting visitor feedback on this exhibit - Creatividad silvestre - today. Do you have a few minutes to answer some questions in exchange for a $5 Amazon gift card? Your answers are kept confidential, and they help us understand how to design improved exhibits for families. Great! I am especially interested in hearing what kids/girls think about the exhibit, because it was designed with you in mind. [Once group agrees, enter their number on tablet.] First I'll ask you some questions and take some notes, and then there will be some questions for you to answer on my tablet.

Interview Questions

What would you tell someone this exhibit is about?/What idea is the museum trying to teach in this exhibit?

This exhibit uses lots of examples from nature. What do you think all these examples are trying to show?

Are you familiar with the term Biomimicry? (Yes/No/Kinda) How would you describe it to someone who has never heard of it before?

In the exhibit, did you see any examples of how nature inspired a solution to a problem? If so, please describe it.

What parts of the exhibit did you spend time with today? [Circle all that apply]

Entrance	Flea	Kangaroo	Garden	Kites	Helmet	Prairie dogs
Design principles doors		Do Biomimicry		AskNature		Transform (lenticular)
Collecting water		Restoring forests		Cooling our cities		Designing for Change
Designing with Nature		Bird beaks		Pathways wall		

Can you choose which part was your favorite?

Can you tell me about this hands-on activity you did? [Options: Helmet, Kites, Garden, Kangaroo, Flea, Prairie Dog. Choose favorite if on list]

What steps did you take to solve this challenge?

Did any parts of this exhibit make you think about your own life or community? (Prompt: Can you tell me more about that? In what way?)

This exhibit has text in both Spanish and English. Is this something you noticed? How did you feel about seeing two languages?

Thank you for those answers! The rest of my questions are on this tablet, and I'm going to give that to you to finish. While she/he/they do that, would an adult from the group mind filling out the demographic information here?

Demographic Questions

Please indicate the genders and ages of the people in your group:

	Gender	Age
Person 1		
Person 2		
Person 3		
Person 4		
Person 5		
Person 6		

Please indicate the race/ethnicity of people in your group: (People may identify as more than one.)

	Person 1	Person 2	Person 3	Person 4	Person 5	Person 6
American Indian or Alaska Native						
Asian						
Black or African American						
Hispanic/Latino						
Native Hawaiian or Other Pacific Islander						
White						
Other:						

Creatividad silvestre Exit Survey

Date: _____ **Data Collector:** _____ **Group #:** _____

What parts of the exhibit did you spend time with today? Select activities you tried, signs you read, and videos you watched. (check box)

☐ Entry area	☐ Flea activity	☐ Kangaroo activity	☐ Rooftop Garden
☐ Lenticular (folding activity)	☐ Do Biomimicry activity	☐ Ask Nature kiosk	☐ 7 Design Principles from Nature
☐ Designing with Nature videos	☐ Bird Beaks	☐ Prairie Dog activity	☐ Collecting Water
☐ Designing for Change videos	☐ Restoring Forests	☐ Cooling Our Cities	☐ Helmet activity
☐ Kites activity	☐ Take action		

Can you choose which part was your favorite? (same list as above)

How much did you enjoy this exhibit? (one to five stars, "not at all" to "a lot!"

In this exhibit, I learned about…	Not at all	A little	A moderate (medium) amount	A lot
Interesting ways that animals and plants solve problems				
How nature can give people ideas on how to solve human problems				
People who are solving problems in their own lives and communities				
Sustainable solutions to human problems (solutions that are good for us AND for nature)				
How I could create or be a part of a sustainable solution based on examples from nature.				

How much do you agree with these statements?	strongly disagree	disagree	not sure	agree	strongly agree
I felt like I could complete the challenges as they were presented.					
This exhibit made me feel more confident that I can design solutions to challenges.					
In this exhibit, I felt like I was doing things an engineer would do.					
This exhibit made me more interested in engineering.					

How much do you agree with these statements?	strongly disagree	disagree	not sure	agree	strongly agree
I enjoyed learning about the examples from nature in this exhibit.					
This exhibit made me think about solving problems in my own life or in my own community.					
I can help find solutions to problems by looking at nature for ideas.					

Your age: _____

Your gender:

- Female
- Male
- Non-binary
- Prefer to describe myself: _____

Engineering Challenge Observation Form

Front

Interaction Information	
Date:	Observer:
Group number:	Time Spent:
Exhibit component/area (please circle): Helmet Kites Garden Kangaroo Flea Prairie Dog	

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, ⭐ for girls 9-14)	**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) **Notes:**	_____ 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)	
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:

Engineering Challenge Observation Form - Reverse

Coding Based on **Behavior**	
Reads or listens to information provided	Before build/test___ During build/test___ After build/test___ No ___ Comments:
Explores resources	Before build/test___ During build/test___ After build/test___ No ___ Comments:
Watches others	Before build/test___ During build/test___ After build/test___ No ___ Comments:
Testing	Single cycle___ Multiple tests___ Continued testing__ Adjusts testing conditions ___ None ___ Comments:
Coding Based on **Talk**	
Brainstorms	Initial design___ Improvements____ None___ Comments:
Goal articulation	Identifies/describes criteria or constraints___ States a goal ____ No___ Comments:
Relates content to prior experience	Yes ___ No___ Comments:
Interprets results	Identifies pros/cons of design___ Diagnoses issues___ Describes what happened___ Explains result _____ None___ Comments:
Coding Based on **Talk and Behavior**	
Goal assessment	Subjectively ___ Qualitatively ___ Quantitatively ___ None___ Compares to past performance ___ Comments:
Considers benefits and trade-offs of materials	Yes ___ No___ Comments:
Applies modifications	Casual __ Directed __ Completes multiple iterations __ None __ Comments:

Pillar Exhibits Observation Form

Front

ENTRANCE PAVILION

Group Notes:

Date: _____
Data Collector: _____
Group #: _____
Total Time Spent (min:sec): _____

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
Circle the target individual from the group, and focus on them for observations and interview questions.

Graphic Wall - "What is biomimicry?"	**Notes**
☐ didn't read ☐ read briefly (a few seconds) ☐ read carefully (>20 seconds, more than one panel) ☐ discussed w/ group members	
Function/Strategy - "Start Exploring"	**Notes**
☐ didn't read ☐ read briefly (a few seconds) ☐ read carefully (>20 seconds, more than one panel) ☐ discussed w/ group members ☐ pressed buttons	

BIOMIMICRY IN ACTION

Group Notes:

Group #: _____
Total Time Spent: _____

Collecting Water	**Restoring Our Forests**	**Notes**
☐ didn't read ☐ read briefly (a few seconds) ☐ read carefully (>20 sec, multiple pages) ☐ discussed w/ group members	☐ didn't read ☐ read briefly (a few seconds) ☐ read carefully (>20 sec, multiple pages) ☐ discussed w/ group members	
Designing for Change video	**Notes**	
☐ didn't watch ☐ watch briefly (a few seconds) ☐ watched at length (>20 seconds) ☐ discussed w/ group members		
Cooling Our Cities (reading)	**Cooling Our Cities - Prism Activity**	**Notes**
☐ didn't read ☐ read briefly (a few sec) ☐ read carefully (>20 sec, multiple pages) ☐ discussed w/ group members	☐ didn't engage ☐ engaged briefly (a few sec) ☐ engaged at length (>20 sec) ☐ discussed w/ group members	

Pillar Exhibits Observation Form – Reverse

NATURE'S DESIGN PRINCIPLES

Group #: _____

Group Notes:

Total Time Spent: _____

Designing with Nature video	**Notes**
☐ didn't watch	
☐ watch briefly (a few seconds)	
☐ watched at length (>20 sec)	
☐ discussed w/ group members	

7 Design Principles from Nature	**Notes**
☐ didn't engage/read	
☐ read or interacted briefly (a few seconds)	
☐ engaged longer (>20 sec, multiple flaps, etc)	
☐ discussed w/ group members	

WORKSHOP

Group #: _____

Group Notes:

Total Time Spent: _____

Lenticular/Folding Activity	**Notes**
☐ didn't engage at all	
☐ read instructions	
☐ started activity	
☐ finished activity	
☐ discussed w/ group members	

Ask Nature Kiosk	**Notes**
☐ didn't engage at all	
☐ browsed briefly (a few seconds)	
☐ engaged fully (>20 sec, searched for more that one answer)	
☐ discussed between group members	

Do Biomimicry Activity	**Notes**
☐ didn't engage at all	
☐ read instructions	
☐ started activity	
☐ finished activity	
☐ discussed w/ group members	

BEHAVIOR CODING

Tracking Engagement at Engineering Challenges and Pillar Exhibits

The opportunity for high engagement at the various Engineering Challenges is relatively consistent, since each one was designed using the C-PIECE Framework and was intended to support a cycle of goal setting, testing, and improvement. The opportunity for high engagement at the different Pillars of *Creatividad silvestre* is less consistent, since some Pillars contain more components to engage with. Biomimicry in Action, for example, contains five different elements for visitors to engage with, including a hands-on activity (Refleja | Reflect) where visitors can play with adjusting a prism to deflect heat. The Entrance Pavilion and Nature's Design Principles Pillars, on the other hand, consist of fewer panels to be read and videos to be watched, and fewer hands-on elements (e.g., panels you can lift to reveal an answer). We therefore established the engagement level coding for the Pillars based on those with the fewest components, so that the less complicated Pillars still had the potential to achieve high engagement with visitors. This also means that visitors at the Workshop Pillar were not expected to display eight different engagement behaviors in order to be coded as "highly engaged." Instead, these visitors could engage deeply with a single element of that Pillar, and still achieve high engagement.

Table 6. **Pillar Observation Engagement Coding**

	Engagement Level	Examples
Pillars	**Low**	Visitor looked or glanced at signage or activities, but didn't pause to read or engage. Visitor read a single signage element or watched a video briefly (no longer than 20 seconds).
	Medium	Visitor read materials or watched a video at length (more than 20 seconds). Visitor read materials or watched a video at length, and also discussed with a group member.
	High	Visitor reads more than one signage element in depth. Visitor tries more than one activity in an area and discusses with group members. Visitor reads signage or watches a video in depth, and then tries an activity.
Engineering Challenges	**Low**	Repeatedly looking at phone or looking away, wandering away, making half-hearted attempts at the activity
	Medium	Moderate focus, 3 minutes or less at activity, 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

Engineering Proficiencies Operational Definitions for Evaluation Observations

Indicator	Definition
Explores resources	Individual(s) in the focal group are learning about what resources are available and how they work. This may include looking at, touching, discussing and/or comparing materials without assembling or placing them, as well as figuring out how the exhibit works or responds to input (pushing buttons, turning knobs, carefully observing), examining models, prototypes, existing designs left by other visitors, sketches or other artifacts that suggest ideas for a design.
Reads/listens to information provided	Individual(s) in the focal group appear to focus on text panels, points to or references the text, reads text aloud.
Watches others	Group observes other groups or individuals participating in the activity or working with materials. Watching others can occur while participating in other behaviors.
Discusses questions/ideas about the process with others	Individuals in the group talk about how they should approach the ideation, construction or testing of their design including what constitutes success and conditions of testing.
Identify/assign roles	Individuals within the group identify and/or take responsibility for specific tasks related to the challenge/problems
Brainstorms ideas	Individuals within the group make suggestions for their design
Discusses/plans design other than materials	Individuals within the group talk about or report considering intended form, function and behavior of their design prior to or during construction
Relates content to prior experience	Individuals in the group associate the current task or design to something they have experienced in the past
Completes the challenge	Testing of the current design iteration successfully meets the criteria of the goal or challenge presented.
Runs through single cycle	Group builds and tests one design with few or no modifications.
Subjective assessment of goal completion	Group defines success in terms of a personally relevant measure
Qualitative assessment of goal completion	Group defines success in terms relative to a general standard or previous performance.
Quantitative assessment of goal completion	Group defines success in terms of a numerical standard.
Completes multiple tests	Group repeats testing of a single design.
Continues testing	Group continues to improve and test a design after the goal was successfully achieved.
Adjusts testing conditions	Individual(s) in the focal group appear to systematically change the conditions under which they are conducting tests.
Identifies/describes criteria or constraints	Group members talk about what needs to be done to accomplish a goal, measures of success of a test or restrictions for the design.
Diagnoses issues	Individuals report or talk about figuring out why the design did not perform well
Identifies pros/cons of design	Individuals in the group talk about what seems to be working well and what seems to be a problem with their design; includes comparisons and trade-offs of design elements and materials
Reevaluates the goal	Individual(s) report or discuss clarification, interpretation and/or intent of the goal
States a goal	Group uses their own words to articulate, define, restate, reiterate or clarify challenge or goal.
Explains results	Group proposes and/or discusses ideas about underlying mechanisms for performance of a design.
Describes what happened	Group summarizes or describes the result of attempting the challenge.
Compares to own past performance or record	Group reports or talks about results of a test in terms of previous trials.
Considers benefits and trade-offs	Group reports or discusses alternative materials and associated potential differences.
Applies casual modifications	Group makes changes, often several at once, to their design with little or no evidence of consideration of how the changes will affect performance or are based on earlier tests.
Applies directed modifications	Group makes changes that improve the performance of a design to address issues to help it achieve the goal.
Completes multiple iterations	Group tests a design after each of several modifications: cycles of modify, test, observe.

Engineering Observation Alignment with C-PIECE Framework Levels

	Beginning	Intermediate	Informed (Advanced)
Coding Based on Behavior			
Taking in info before starting challenge: • reads or listens to info provided • explores resources • watches others		Prematurely attempts challenge (Does 1 in the list before starting)	Delays design decisions (Does 2 in the list before starting)
Testing		Multiple tests Adjusts testing conditions	Continued testing
Coding Based on Talk			
Brainstorms		Brainstorms initial design	Brainstorms improvements
Goal articulation	Perceives goal as straight forward		States goal Identifies/describes criteria or constraints
Relates content to prior experience			Yes
Interprets results		Identifies pros/cons of design Diagnoses issues Describes what happened	Explains result
Coding Based on Talk and Behavior			
Goal assessment	Subjectively	Qualitatively	Quantitatively
Considers benefits and trade-offs of materials			Yes
Applies modifications	Casual (modifications at random, or based on aesthetic or superficial characteristics	Directed (with a specific intent)	Completes multiple iterations

SAMPLE CHARACTERISTICS

Engineering Observations

Number of Observations at Each Engineering Challenge

Answer	%	Count
Flea	17.27%	24
Garden	12.23%	17
Helmet	20.14%	28
Kangaroo	17.99%	25
Kites	16.55%	23
Prairie Dogs	15.83%	22
Total	100%	139

Target Groups

Answer	%	Count
Target priority 1: girl 9-14	59.71%	83
Target priority 2: girl 6-16	15.11%	21
Target priority 3: any child 9-14	21.58%	30
other child (non-priority)	3.60%	5
adults (non-priority)	0.00%	0
Total	100%	139

Group Type

Answer	%	Count
child alone	0.72%	1
children only	14.39%	20
child(ren) and adult(s)	84.89%	118
adults only	0.00%	0
Total	100%	139

Number of People in Group

Number of People	%	Count
1	0.72%	1
2	33.09%	46
3	28.78%	40
4	18.71%	26
5 or more	18.71%	26
Total	100%	139

Pillar Observations

Number of Observations at Each Pillar

Answer	%	Count
Biomimicry in Action	31.37%	32
Entrance Pavilion	24.51%	25
Nature's Design Principles	16.67%	17
Workshop	27.45%	28
Total	100%	102

Target Groups

Group	%	Count
Target priority 1: girl 9-14	54.90%	56
Target priority 2: girl 6-16	23.53%	24
Target priority 3: any child 9-14	18.63%	19
other child (non-priority)	1.96%	2
adults (non-priority)	0.98%	1
Total	100%	102

Group Type

Answer	%	Count
child alone	5.88%	6
children	5.88%	6
child(ren) and adult(s)	87.25%	89
adults	0.98%	1
Total	100%	102

Number of People in Group

Number of People	%	Count
1	5.88%	6
2	37.25%	38
3	24.51%	25
4	17.65%	18
5 or more	14.71%	15
Total	100%	102

Survey Participants

Gender

Answer	%	Count
female	66.02%	68
male	30.10%	31
non-binary	1.94%	2
other/additional	1.94%	2
Total	100%	103

Target Groups

Answer	%	Count
girl 9-14	37.86%	39
girl 6-16	18.45%	19
any child 9-14	23.30%	24
other child	6.80%	7
adult	13.59%	14
Total	100%	103

Group Race/Ethnicity

Answer	%	Count
American Indian or Alaska Native	0.97%	1
Asian	4.85%	5
Black or African American	0.97%	1
Hispanic	16.50%	17
Mixed Race/Ethnicity	24.27%	25
White	51.46%	53
Other	0.97%	1
Total	100%	103

ADDITIONAL DATA BREAKOUTS

Pillar Exhibits

Engagement Level - All Participants - Pillar Breakout

Field	Biomimicry in Action		Entrance Pavilion		Nature's Design Principles		Workshop	
low	16%	5	12.00%	3	29.41%	5	3.57%	1
medium	28%	9	32.00%	8	70.59%	12	46.43%	13
high	56%	18	56.00%	14	0.00%	0	50.00%	14
Total		32		25		17		28

Time spent - Pillar Breakout

Field	Biomimicry in Action		Entrance Pavilion		Nature's Design Principles		Workshop	
less than 1 min	10.3%	3	17.4%	4	25.0%	4	0.0%	0
1-2 min	27.6%	8	30.4%	7	37.5%	6	9.1%	2
2-3 min	10.3%	3	21.7%	5	6.3%	1	4.6%	1
3-5 min	37.9%	11	26.1%	6	31.3%	5	31.8%	7
5 min or more	13.8%	4	4.4%	1	0.0%	0	54.6%	12
		29		23		16		22