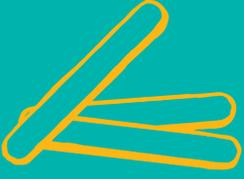
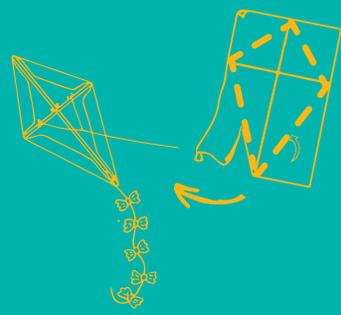


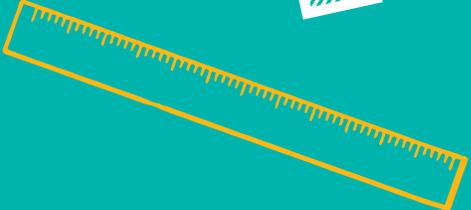
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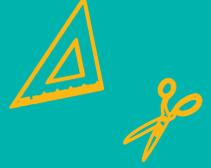
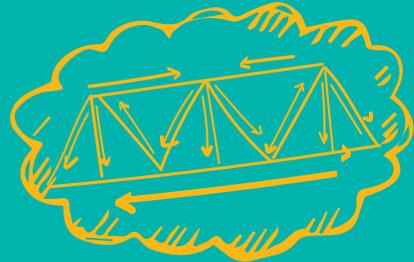
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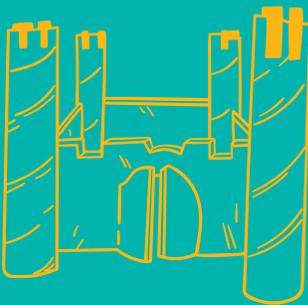
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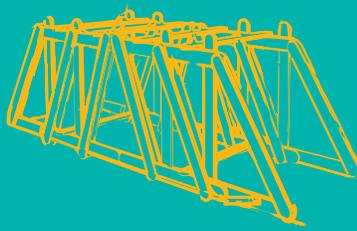
IMPROVE



24"



BRAINSTORM



The Bay Area Discovery Museum (BADM) is an innovative, multifaceted children’s museum that is transforming the way children learn and contribute to an increasingly complex world. We provide child-directed, research-backed, STEM-based early learning experiences that develop creative problem-solving, a fundamental skill best learned in early childhood when brain development is at its peak. This document tells the story of the development and testing of the museum’s Try it Truck, an engineering lab-on-wheels that travels directly to schools, libraries, and community organizations throughout the Bay Area. We hope this documentation is useful to other organizations looking to develop engineering and maker-centered mobile learning experiences in their area.

Introduction

In spring 2017, BADM launched and piloted the Try It Truck, an engineering lab-on-wheels that traveled directly to schools and libraries throughout the Bay Area to provide hands-on early engineering experiences to children in kindergarten through fifth grade. The Try It Truck program introduced children to the engineering design process and encouraged children to take risks and try new ideas. Using a mixture of high- and low-tech tools—such as laser cutters, 3-D printers, hammers, and pliers—children explored a series of hands-on stations (both on and off the truck) where they collaborated, experimented, and designed solutions to engineering challenges.

The Problem and Process

As elementary school teachers dive deeper into Science, Technology, Engineering, and Math (STEM) learning, particularly in light of California’s adoption of the Next Generation Science Standards (NGSS), they have faced many obstacles. Through interviews conducted with teachers, we learned that, at a basic level, many elementary school teachers cannot envision what engineering could and should look like in their classrooms. Many identified the field and practice of engineering as unfamiliar, difficult, or male-dominated and experienced these as barriers to their ability to effectively incorporate engineering into their classrooms.

Another challenge for teachers has been the lack of administrative support for dedicating instructional minutes to content areas other than language arts and mathematics. Since these have been the only two areas tested for accountability purposes in California, pressure to focus on language arts and mathematics is often heightened in schools with lower test score performance. Further, schools serving a high proportion of low-income families often lack the funds for teacher training, field trip buses, or tools and materials for their classroom.

To address these problems, we proposed a bold solution to create a mobile program that would travel throughout the greater San Francisco Bay Area. Our stated goal was to increase awareness of and access to engineering for teachers, students, and families. In practice we would work to support teachers, students, and families to experience, value, and understand engineering as a mindset that can be used to find and solve problems, rather than solely as an academic or career field.

At BADM, we took the position that children can develop an engineering mindset by engaging in problem-finding and problem-solving first-hand. To guide children in developing this mindset, we introduced participants in our programs to a developmentally-appropriate engineering design process composed of three iterative steps: Think about the problem; Make a prototype; and Try and retry.

ENGINEERING DESIGN PROCESS

THINK

ABOUT THE PROBLEM

MAKE

A PROTOTYPE

TRY

AND RETRY

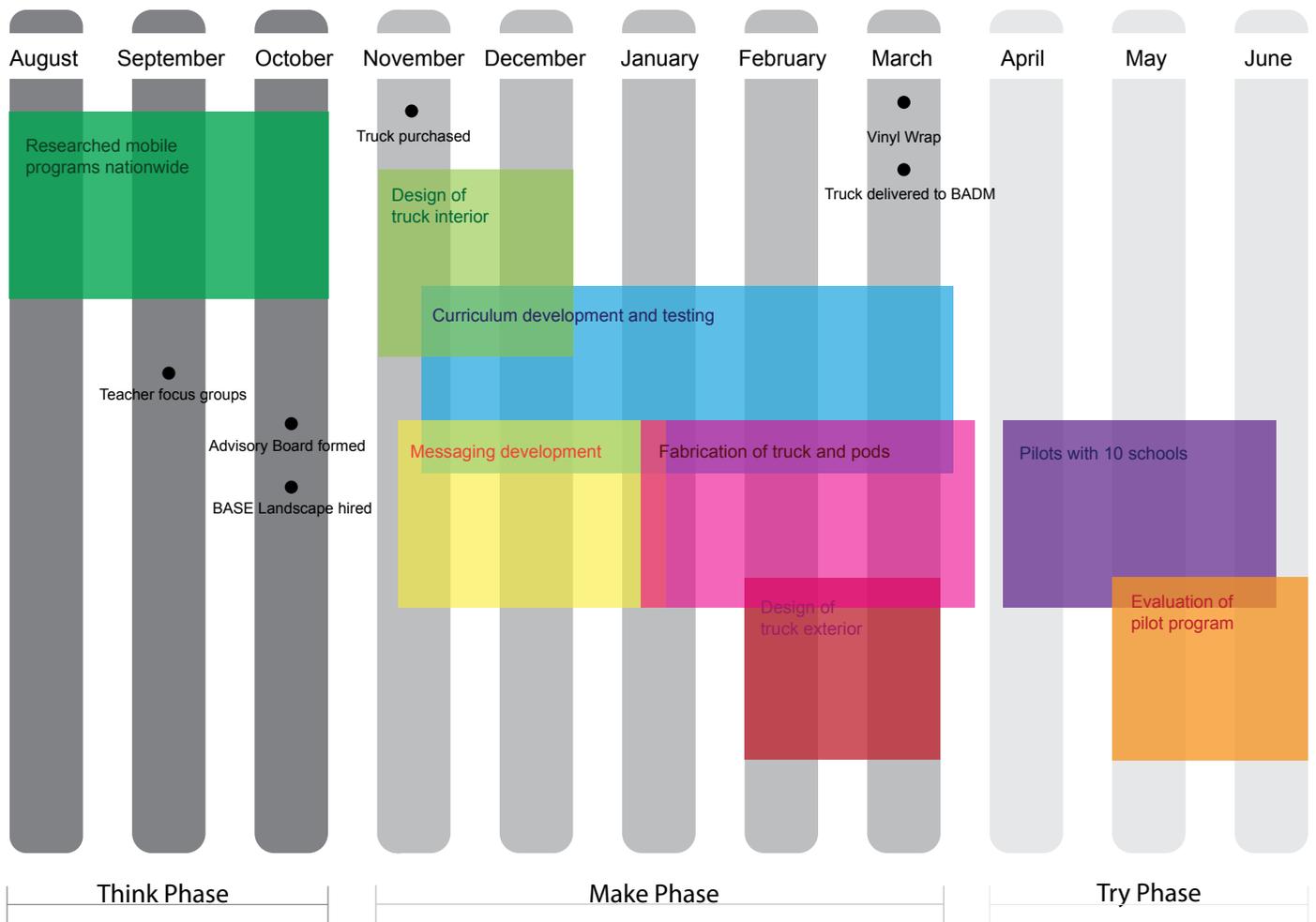


Bay Area
Discovery
Museum

With the first step of “Think about the problem,” children were asked to find a problem or challenge to solve, explore different materials or tools they might use to do so, and generate different potential solutions. Then, children put this thinking into doing as they “Make a prototype,” often using recycled, craft, or natural materials and both high- and low-tech tools. In the process of creating their prototypes, children were encouraged to “Try” their idea out, observe what happens, and then think about ways to make their prototype even better. Because the engineering design process is an iterative cycle, we encouraged participants to go through these three steps multiple times as they refine their potential solution and experiment with different tools, materials, and approaches. By finding and solving problems using this engineering design process, young learners build creative problem-solving skills, dig into important content knowledge, and are empowered in their ability to help others and themselves.

The engineering design process has been at the core of our work with the Try It Truck, not only as the basis for our curricular content, but also as the approach we ourselves took in order to tackle the problem at hand: How might we create opportunities for Bay Area communities (including teachers, caregivers, and children) to experience, value, and understand engineering?

The timeline below outlines our progression through the three phases.



THINK

Phase



At BADM, we took the position that engineering is a teachable mindset that every child can use to tackle challenges. Children are naturally inquisitive, creative, and curious about the world around them—a perfect mindset for embracing and solving hands-on engineering challenges. To differentiate ourselves from other mobile STEM programs, which focus on preparing students for careers in engineering, the Try It Truck emphasized the engineering design process. Our goal was to show the educators, parents, and children how fun and rewarding it is to use the engineering design process to solve everyday problems, while giving children the confidence and skills to improve the world around them. When children engage in the engineering design process, they are actively building and applying critical 21st century skills such as collaboration, critical thinking, and creativity, all while becoming more confident problem solvers.

To aid our thinking in how to approach the creation and implementation of the Try It Truck, we put together an Advisory Board of experts from around the U.S. who work in industry, nonprofits, and academia and are often tasked with communicating complex engineering concepts to youth. The board met virtually and advised us on the future of engineering education, appropriate messaging around engineering, and vetted our engineering design process.

Messaging

To help us identify and articulate the program’s mission, vision, audience, program name, and key messages, we hired an outside communications consultant. To start, the consultant did a competitor audit and analysis, interviews with internal stakeholders on program goals, and an overview of early engineering education. From there, they identified four key audiences for the Try It Truck, outlining each audience’s current perceptions and attitudes towards engineering and our larger communications goals and outcomes for each audience. These four target audiences were: K – 5th grade teachers and informal educators; caregivers with children in Pre-K – 5th grade; children in Pre-K – 5th grade; and Bay Area residents.

With these audience profiles and clearly articulated communications goals and outcomes, the museum now had guiding principles to approach messaging for each audience. For example, our communication goals for K – 5th grade teachers and informal educators were to show them that they are capable of teaching hands-on engineering activities. Through the Try It Truck experience and messaging, our desired outcomes were for teachers and informal educators to feel confidence in their STEM teaching abilities and enthusiasm towards engineering, while also feeling like they could easily incorporate hands-on engineering activities into lesson plans. Further, we wanted this audience to recommend the Try It Truck to other educators and tell their fellow educators, “if I can do this, so can you.”

Educational Goals

Once we zeroed in on our primary audience as elementary educators, we outlined clear educational goals for the program. Our intention was that all children who participate in Try It Truck programs:

- Engage in the iterative engineering design process in order to build creative problem-solving skills.
- Practice working collaboratively as they ask questions, plan, build, test and improve their solutions to an identified problem.
- Build flexible thinking skills and persevere in the face of engineering challenges, constraints, and failures.
- Be exposed to a variety of technologies and tools, both familiar and new, that humans have developed to solve problems and learn to use them safely.
- Recognize that materials and tools matter, and that some are better suited for certain situations than others by experimenting with a variety of tools and materials and repurposing them in new ways.
- Advance their STEM content knowledge, with an explicit focus on engineering.

These educational goals informed and guided both our vehicle design and our curriculum design, whether it was in the tools or materials we chose to incorporate, in the facilitation style employed during programs, or a myriad of other decisions we made during our design process.

Vehicle Choice and Design

After investigating a variety of mobile educational programs across the country, we narrowed our vehicle choices to the following options:

- Small option (e.g., a renewable energy-powered vehicle or other roughly sedan-sized vehicle)
- Medium option (e.g., a sprinter van or delivery-sized vehicle)
- Large option (e.g., a school bus or RV)

While each vehicle option varied in price, they also differed in the type of programming that could be offered. The small option would allow us to be highly flexible in terms of parking and fitting into urban areas, but would not allow us to bring a large variety of tools and materials, or invite visitors onto the vehicle itself. The medium option would allow us to still fit into a traditional parking spot, bring some children on board the vehicle, and provide significantly more storage options. The large option would limit the spaces that we would be able to fit the vehicle at a school or community site and would require our educators to get commercial driver's licenses, but it would allow us to bring 16 – 18 children on board at any one time. After weighing all of the pros and cons, we decided to purchase a delivery-sized vehicle that would allow 8 – 10 children to enter the vehicle at once, yet not require a special license for drivers which can be a barrier for staffing.

Being ADA compliant was another important factor in our vehicle decision. Many mobile programs are not ADA accessible but are ADA compliant. ADA accessibility is directly tied to the physical design and structure of a space, and most mobile programs we observed during our research did not have vehicles that were large enough to support ADA-required specifications. In choosing to purchase a medium-sized vehicle, we made the decision to be an ADA compliant program and provide access to all of our visitors by to facilitating the majority of our programming outside the vehicle itself.



After reviewing bids from three local design firms, we hired BASE Landscape Architecture to assist us with custom outfitting a vehicle that aligned with our vision and educational goals. Due to our compressed timeline, BASE was also a compelling choice because they would be our sole point person on all three phases: vehicle acquisition, custom design, and custom fabrication.

Name and Visual Identity

The Try It Truck name and visual identity were built around our vision to give children the confidence and skills to improve the world around them using the engineering design process. Our goal was to have a name that was child-friendly, gender-neutral, and inviting. We began with a brainstorming session with various education and communications staff at the museum and workshopped words and phrases that embodied the engineering design process and the excitement we wanted children and educators to feel when they participated in the program. The brainstorm session led us to pinpoint five different themes: engineering, ideas, making, imagination, and building. Words that surfaced repeatedly were: engineering, studio, station, lab, toolbox, playground, engines, workshops, tools, truck, wheels, curiosity, invent, and building. From this naming session, we landed on three possible names for the program: Roving Toolbox, Idea Engine, and Try It Truck.

To help narrow in on a name, we surveyed our Advisory Board and pilot site teachers. The majority (16 of 19) selected Try It Truck. One advisory board member said, "I like Try It Truck because it is an invitation. It automatically says 'this truck is for you to come and learn.'" Another advisory board member said, "Roving Toolbox doesn't seem girl friendly. It can be intimidating if you don't know how to work with tools and that could be in their head before they even get to the program...Try It Truck plays into the growth mindset." A different advisory board member added, "I think Try It Truck is really catchy! It also sends a message to try—try new things, try hard, try your best, try again. It's great."

Key Takeaways of Think Phase

- 1. Know your problem.** What problem are you trying to solve? Write it down and be specific. Collect some data to fine tune your question. Then, consider the various factors within your locus of control and where your organization fits within the overarching solution.
- 2. Know your audience.** It is hard to find a good solution for someone if you don't know what makes them tick. Take the time to think through what you want your audience to think, feel, say, and do as a result of your work.
- 3. Ask for help when you need it.** We outsourced consultants to focus on messaging, graphics, and vehicle design and fabrication. If you have the budget, relying on experts can create efficiencies to expedite your timeline and save staff time in the long run. We learned this lesson the hard way in regards to the messaging component of our project, which we initially tried to do internally and later hired a consultant.
- 4. Focus, focus, focus.** Part of need-finding is building empathy for your end users. It is hard to create an educational program that will meet the needs and wants of all users and do it well. We narrowed our focus on the engineering design process, elementary aged youth, and school teachers for our pilot.
- 5. Learn from others.** There is no need to re-invent the wheel. We visited close to a dozen other mobile or engineering programs, in our state and across the United States and spoke to even more educators, in order to grasp what had been done before, in order to shape our direction.

MAKE Phase



The first step of physically making the Try It Truck was to purchase the appropriate medium-sized vehicle. We settled on a 2009 12' Step Ultimaster van due to its low mileage, high ceiling (allowing adults to move easily throughout), relative ease of maneuverability, and ability to fit inside a traditional parking spot. Once the vehicle was purchased and turned over to BASE for custom-outfitting, we embarked upon an iterative process of interior and exterior design.

Interior Design

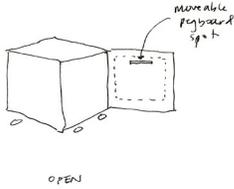
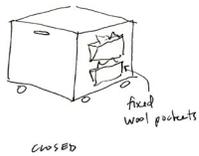
With the decision to serve large groups of children, ranging from 60 – 80 children at one time, we knew that purchasing a medium-sized vehicle would require us to conduct most of our hands-on programming outside of the vehicle. We also made the decision early on to include high-tech digital fabrication equipment inside the vehicle, even though the programming that would accompany it was unclear and largely untested. These two factors drove our decision to create a vehicle and programming that was modular, flexible, and easy to set up and clean up. To do so, we designed custom rolling carts, which we called pods, that can fit a large number of supplies, roll out on wheels easily, and have a designated spot on the vehicle so they can be secured in transit. All of the pods have locking caster wheels, drawers that can be swapped out, and are easily left on-site at BADM when not in use.

Another important component was ensuring that all of our workstations, materials, and design choices were made with our primary users (children ages 5 – 10) in mind. We designed the pods to have varying child-friendly heights from 24" to 30" and applied cushions and protectors to sharp corners on the vehicle.



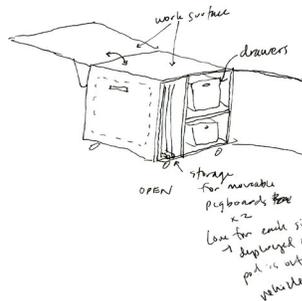
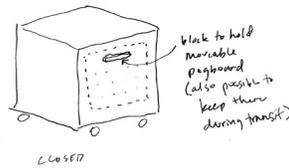


POD SKETCH #1
POD Design - Initial Sketches

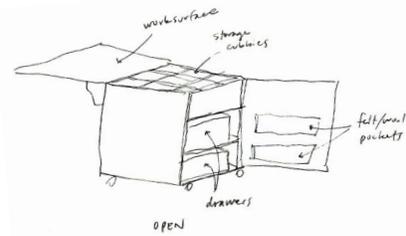
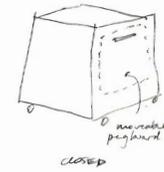


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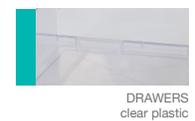
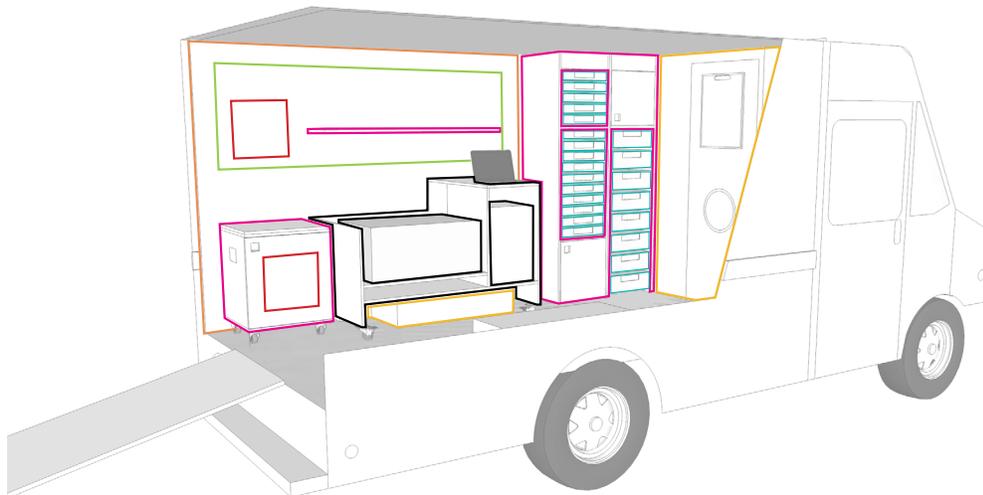
POD SKETCH #2
POD Design - Initial Sketches



POD SKETCH #3
POD Design - Initial Sketches



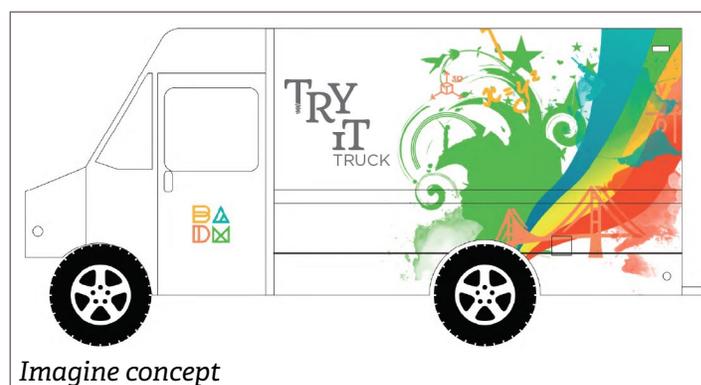
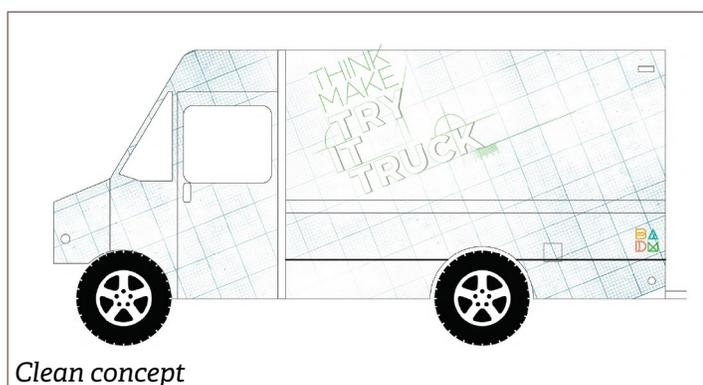
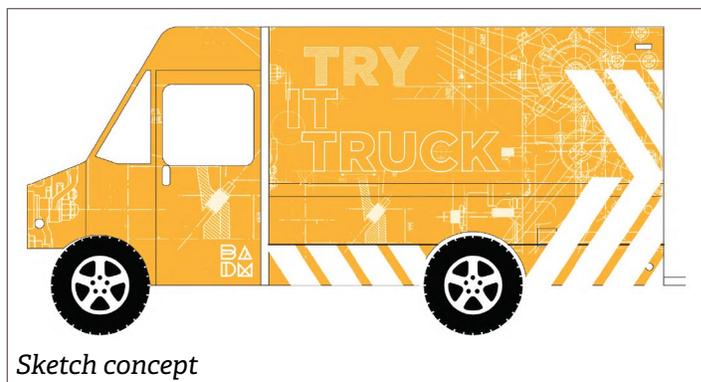
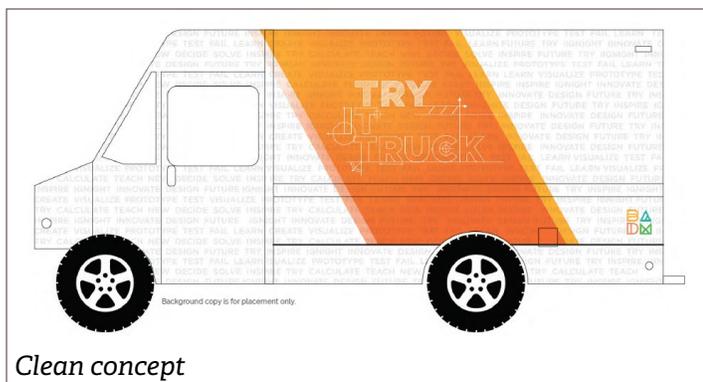
BADM M.E.L.
MATERIALS
Driver Side



Exterior Design

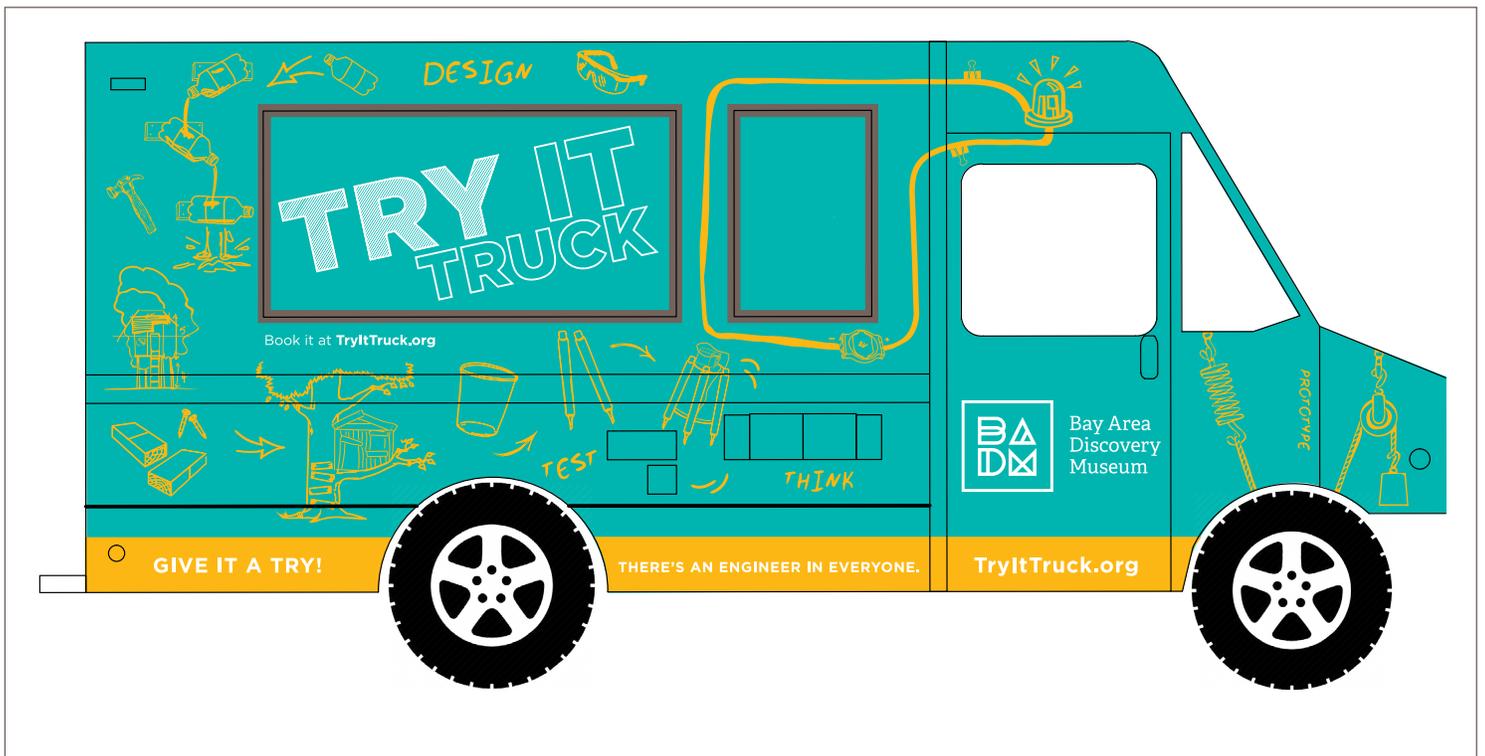
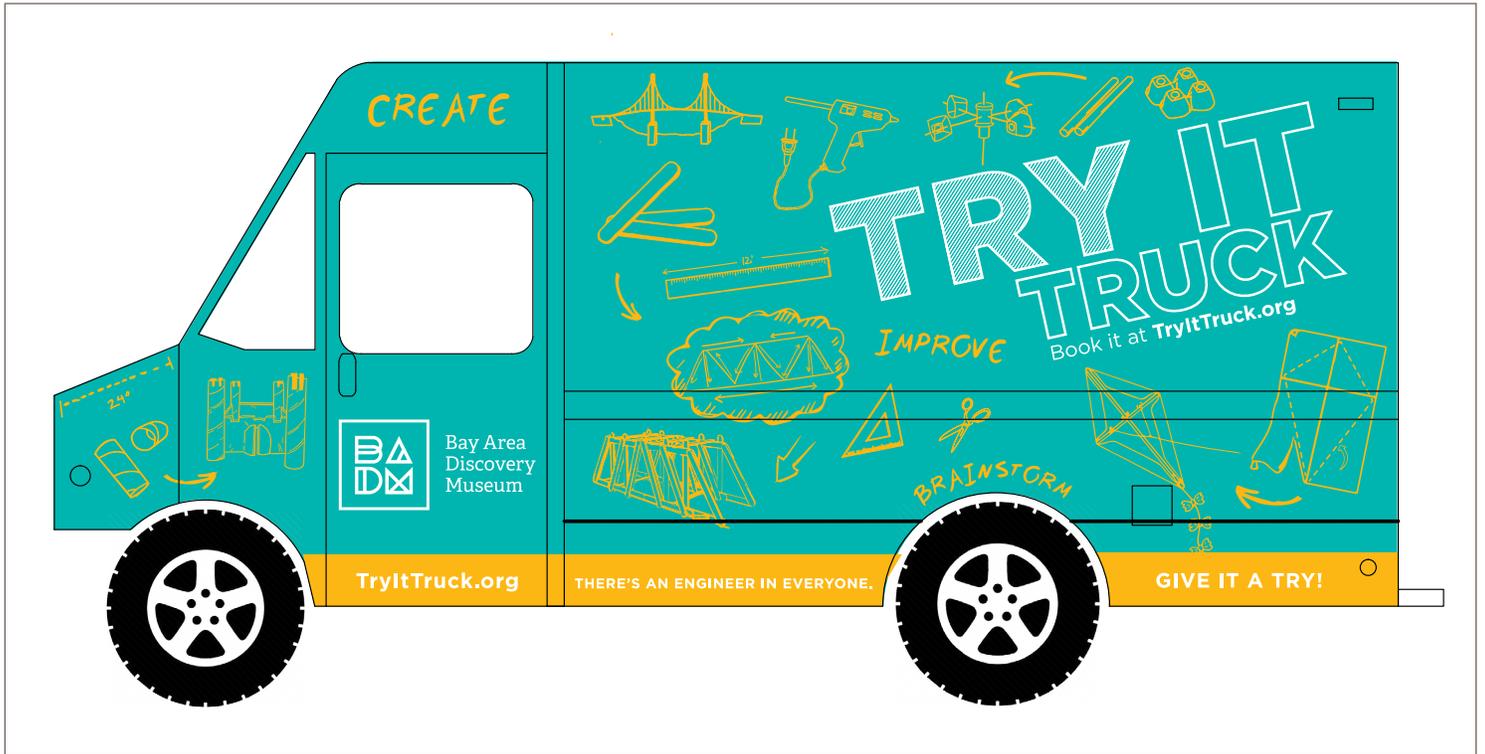
We turned to a graphic designer to help define the visual identity and graphic treatment for the outside of the physical vehicle. Our goal was to pull through the engineering design process visually and to position the vehicle as an important extension of the museum. Our directive to the designer was to create fun and playful visuals that reflect action and activity that are bold and eye-catching, while still maintaining a sense of maturity. Further, we wanted the imagery on the vehicle to convey important engineering concepts such as problem-solving, interacting with the world around you, and working with people.

The graphic designer developed three concept directions: clean, sketch, and imagine.



From these concepts, we chose the sketch concept because we liked how it played off the iterative process of trying out different ideas. It played well with the name Try It Truck and our goal to promote the engineering design process.

The final overall design on the truck is meant to look like a child's sketch book and the iterative process of testing out and trying ideas. Below are photos of where the design landed.



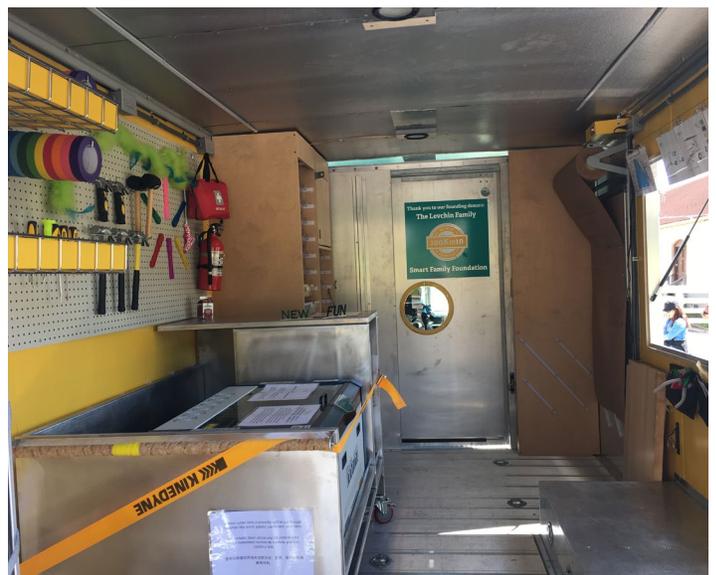
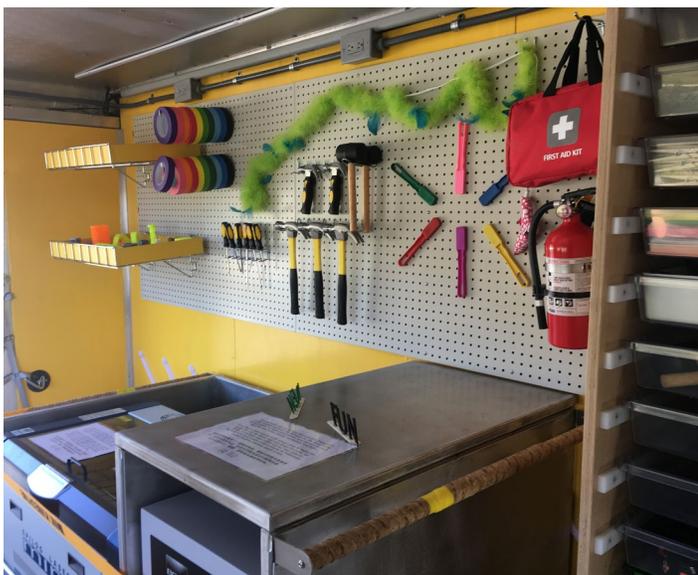
Curriculum Development

Alongside the physical development of the vehicle, we wrote curriculum, the life of the program. We decided to try out two different program structures: 1) a one-day, introductory, interest-building experience; and 2) a three-day deeper dive, intensive experience. Both are described in more detail in the Try and Retry phase.

In the process of writing curriculum, we ran focus groups with elementary school teachers. We found that teachers were nervous to introduce content that might overwhelm students or be unfamiliar to them in a relatively short one or three day program. To address this concern, we chose broad, locally relevant content themes so the children would be able to bring some background knowledge to their experience. For the one day programs, we crafted eight different hands-on, discovery oriented stations around the theme of “Engineering in and on the Bay.” The three-day program was structured around the theme of “Designing Shelters for Local Animals” with a focus on the hummingbird, a very familiar animal to the children in the local area.

We also learned that educators are often excited to use interesting and impressive tools and technologies, but worry what happens once the Try It Truck leaves their school. In response to this concern, and to echo BADM’s commitment to broadening access to technology through the world’s first early childhood Fab Lab, we built the Try It Truck curriculum around both high- and low-tech tools. While high-tech tools (such as a laser cutter or 3-D printer) may be unfamiliar or out of reach for many elementary schools, hand tools (such as a hammer, screwdriver, or pliers) are much more accessible. This desire to balance both digital and analog making within our program fueled our decision to also use real tools, rather than relying on plastic or simplified versions. We inherently trusted that children, as young as 5 years old, were capable of using tools safely while exploring their properties and determining which tools are the best fit for a specific purpose.

And while the Try It Truck is its own distinct program within BADM, we wanted it to echo the site and educational experiences at the museum, particularly through the design and choice of materials. During every Try It Truck program, children explored a wide diversity of materials, many of which are recycled or even foraged from our unique site in a National Park (i.e., bark, sticks, and eucalyptus pods). All of our programming was rooted in the Next Generation Science Standards and used grade-level appropriate vocabulary, images, and facilitation strategies to engage learners from ages 5 – 10 in active STEM learning.



Key Takeaways of Make Phase

- 1. Design should echo program structure, not vice versa.** Create a concrete list of programmatic goals before you embark on any physical or curricular design. Once you know what you want your program to achieve, tailor the design and construction of your vehicle and program experience to support these goals.
- 2. The right tool for the right job.** It is important to ask yourself “why this tool?” before building your program or space around it. In particular, the choice between high- and low-tech is one that we had to make early on since it influenced many other aspects of the design. Keep in mind the amount of time you will spend with children, your budget, and the educational goals of your program.
- 3. Visuals matter.** We set out to change the narrative about early engineering from being an intimidating, unfamiliar one to an inviting, engaging experience. And one important way we addressed this was through the intentional choices around images, colors, words, and materials for both the interior and exterior of the vehicle.
- 4. Consider setup and cleanup.** The time and effort involved in program setup, cleanup, and transportation are often some of the biggest challenges people face. Our design prioritized issues around tool and material storage and organization as well as deployment of pods and tables to maximize efficiency.
- 5. Be flexible.** Make sure your vehicle allows for testing, iteration, and flexibility where possible. Our pod design allows us the freedom to change out both low- and high-tech tools with the adaptation or creation of a new pod, not an entire overhaul of the vehicle.

TRY and ReTry Phase



We developed and tried out two different program structures: 1) a large group, introductory workshop we called Engineering Extravaganza, and 2) a smaller group, deeper dive sequence of workshops we called Engineering Intensive. Through these two types of programs, we wanted to investigate the connection between program length/depth of engagement and impact on educational outcomes in regards to engineering education with our elementary school users.

Engineering Extravaganza Programs

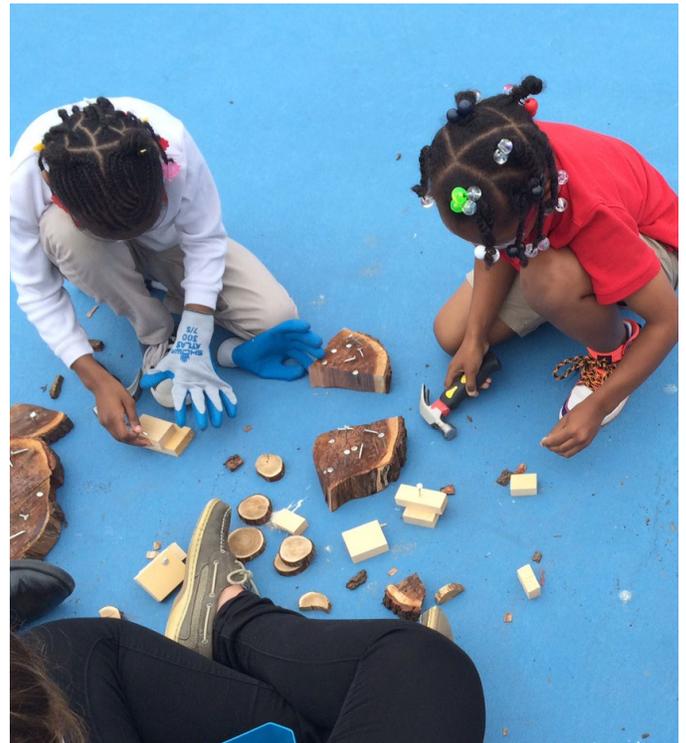
We envisioned Extravaganza programs to be an exciting introduction to the world of early engineering for mixed grade level groups. During Extravaganza programs, young engineers explored a series of hands-on stations featuring engineering challenges and a variety of tools, from hand tools (such as hammers and pliers) to high-tech tools (such as a laser cutter and 3-D printer). Through individual and collaborative activities both on and off the Try It Truck, students learned about the engineering design process as they creatively solved problems using math and science.

One 75-minute Extravaganza session was designed to engage with 50 – 80 children (the equivalent of 2 – 3 classroom cohorts). This structure allowed us to run up to three Extravaganza sessions within one single school day, reaching 150 – 240 children over the course of the entire day. For many elementary schools, this translates to three or more grade levels, or even the entire school community, served in a single day of programming.

Each 75-minute session was broken down as follows:

- Program and engineering design process introduction (20 minutes)
- Child-directed engineering and tool station exploration (45 minutes)
- Reflection and debrief of experience (10 minutes)





Engineering Intensive Programs

For teachers and schools ready for a longer and more intensive early engineering experience, we developed a three-day Engineering Intensive program. Over the course of three school days, students used both the engineering design process and tools to solve problems. Through project-based STEM exploration, students worked collaboratively as they asked questions, planned, built, tested, and improved their solutions to an identified problem.

The Intensive programs were broken down as:

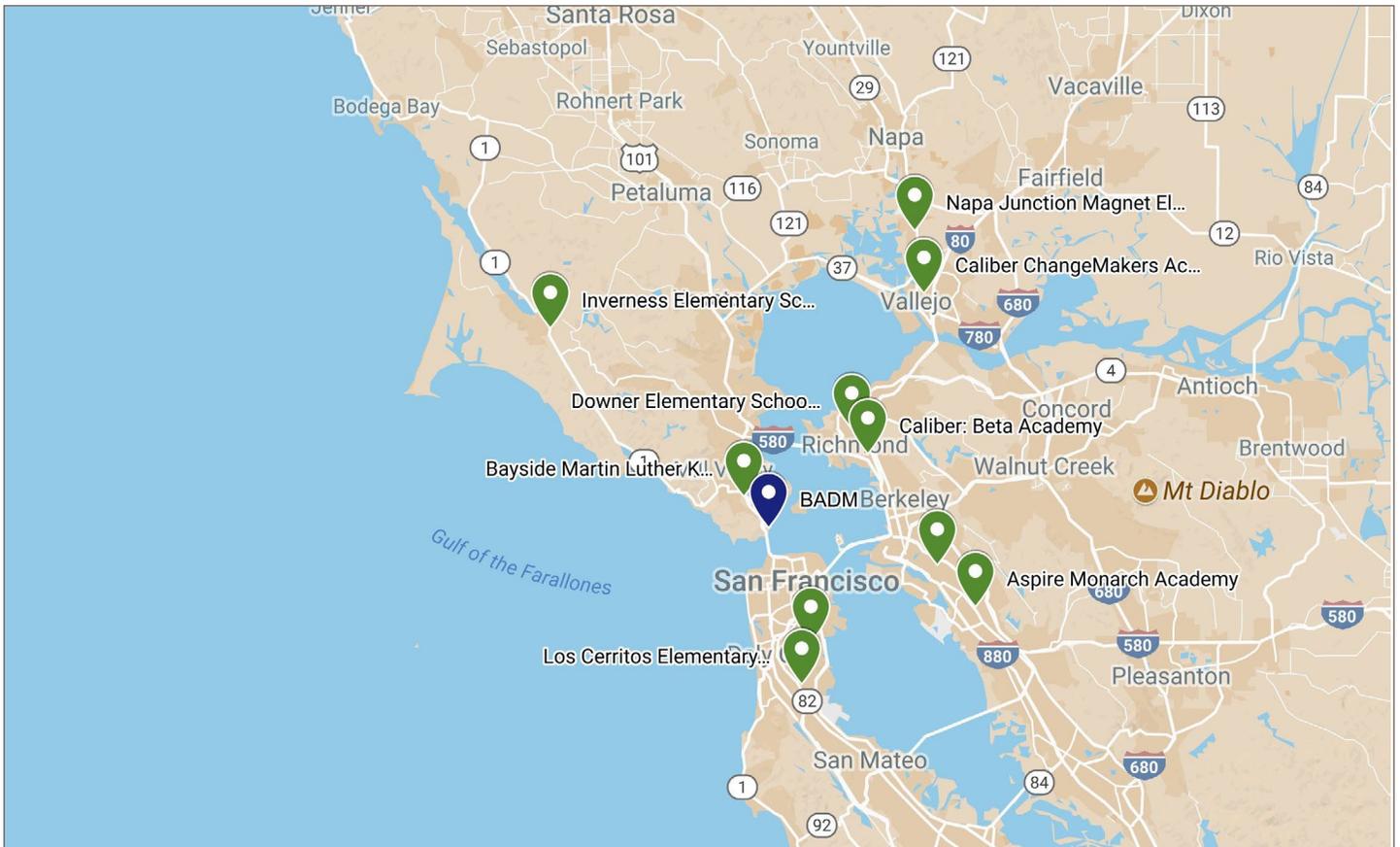
- On Day 1, students were introduced to the engineering design process in an active and exciting way as they used it to solve a challenge aligned to NGSS life and physical science standards.
- On Day 2, students investigated physical properties of diverse materials and experimented with hand tools and digital fabrication tools through hands-on station exploration.
- On Day 3, students used both the engineering design process and high- and low-tech tools to solve a new NGSS-aligned challenge.

Intensive programs were structured as 75-minute sessions throughout the school day, but only have one classroom cohort per session and allowed us to work with the same group of children every day for three days. For many schools, this translated to serving all classrooms in one grade level. Intensives allowed children and educators to explore more NGSS disciplinary core ideas and content areas while also giving them more time and practice with both digital fabrication and hand tools. While children were able to observe high-tech tools in action during the Extravaganza programs, during the Intensive programs, they were able to engage in digital design.

Pilot Schools

Developed as an access program, we worked to establish and build relationships with educators, children, and families throughout the Bay Area through the Try it Truck. Therefore, when it came time to try out our vehicle and programming, we spread out our 10 pilot partner schools across the many, diverse counties throughout the Bay Area. We were also committed to working only with Title I schools for our free pilot program.

Try it Truck School Pilot Partners 2017



Evaluation

One of the most important parts of trying out our pilot program was to gather feedback on its impact, challenges, and successes along the way. We integrated many different layers of evaluation into our pilot through: staff reflection and debriefs, teacher and chaperone surveys, structured debriefs with children at the end of each program, and photos taken in the course of setup, facilitation, and cleanup.

Staff Reflections

We developed a staff reflection form to keep track of supply and material usage, tools in need of repair, and other issues as they came up. Keeping debriefs to short, ongoing internal conversations also helped us improve activity stations and program logistics in small, incremental ways throughout the whole pilot, rather than waiting until the end to make adjustments.

Feedback from Children

During debriefs with children at the end of each program session, we first asked children to reflect on components of the experience that were fun and those that were hard. Then, we prompted them to reflect specifically on different tool and activity stations in order to gather information about which stations were already engaging and which could be improved to be more challenging or interesting.

Students' favorite stations were consistently the following three: the hammer exploration station; take it apart station with recycled electronics; and water table station. Children often noted that one of their favorite parts of the experience was being able to decide which stations to explore and how to solve problems using materials of their choice. They also highlighted that being able to try out ideas—such as testing their boats in the water table—and then go back and make them even better was important to feeling excited and engaged rather than overwhelmed during the engineering challenge stations.

Feedback from Chaperones

We gathered feedback and reflections from adult chaperones, typically parents. We asked each class to provide at least three chaperones per session and encouraged chaperones to familiarize themselves with a specific activity station and act as a support facilitator during the program. Following each program session, we asked chaperones to fill out a brief survey (translated into English and Spanish) about their perception of the programs.

In the survey, we asked chaperones to rate their agreement with the following statements on a scale of strongly disagree to strongly agree.

“Today I tried something new” – 95% of respondents agreed or strongly agreed with the statement.

“Today I had fun.” – 97% of respondents agreed or strongly agreed with the statement.

We also asked chaperones to reflect on the following, “How did today’s programming affect, if at all, how you will interact with your child during future learning experiences?” Some highlights from respondents’ answers include:

“Reminds me to ask open-ended questions and allow him to fail on his own and try, try again.”

“I’ll let her get immersed in an activity as deeply as she wants without guiding her to try everything. Also I’ll ask her how to make something better.”

“It encouraged ‘hands-on’ interactions. Really liked the use of tools for the children.”

Feedback from Teachers

As pilot partners, the teachers we worked with received free Try It Truck programming and post-visit resources to extend their experience. In return, they provided detailed evaluative feedback to us in the form of digital surveys, phone interviews, and informal conversations and email exchanges. We encouraged teachers to give us feedback in two core areas: 1) logistical components of the program, such as scheduling, session length, group sizes, pricing, and pre-visit orientation; and 2) educational components of the program, such as facilitation, STEM content, station activities, and post-visit resources. Major takeaways from teacher feedback along with our own observations in each area are shared below.

Logistics and Communication

- Try It Truck programs disrupted the natural flow of the school day due to the large space requirements, which often overlapped with the space used for lunch or recess. Therefore, it was difficult for one teacher to take charge of coordinating and scheduling the visit. **Going Forward:** We will be involving administrative staff in the program registration process to lessen the logistical burden placed on teachers. We will also expand our pre-visit resources to include documents on “Space and Facility Requirements” and “What to Expect During Your Program” that clearly outline what is needed and how teachers and students can prepare to optimize their experience.
- While we improved our set up and clean up routines, we still required 1.5 hours at the start of the school day in order to have all of our activity and tool stations up and running. One major challenge we encountered was connecting to the school’s wifi network. **Going Forward:** We plan to contact schools about wifi information in advance.
- The 75-minute session length was just right for all of our programs, regardless of grade level, because it allowed children to explore stations without giving them the space to become tired, bored, or frustrated. Having between 6 – 8 stations per session was necessary so that each station did not get too crowded, which is more likely to lead to frustration, interpersonal conflict, or careless use of tools. **Going Forward:** We will continue with the same session length and variety of stations.



Educational Components

- Many administrators and teachers noted that it was important to offer both a light-touch, introductory program (our Engineering Extravaganza option) as well as a deeper dive program (our Engineering Intensive option) so that educators can opt into the level of engagement and commitment that they are ready for and that best meets their needs. **Going Forward:** While we will be changing the name of our deeper dive programs to Engineering Expeditions—largely based on teacher feedback that the title Engineering Intensive was just a bit too intense—we will be keeping both program types next year in order to continue giving teachers the choice to opt in.



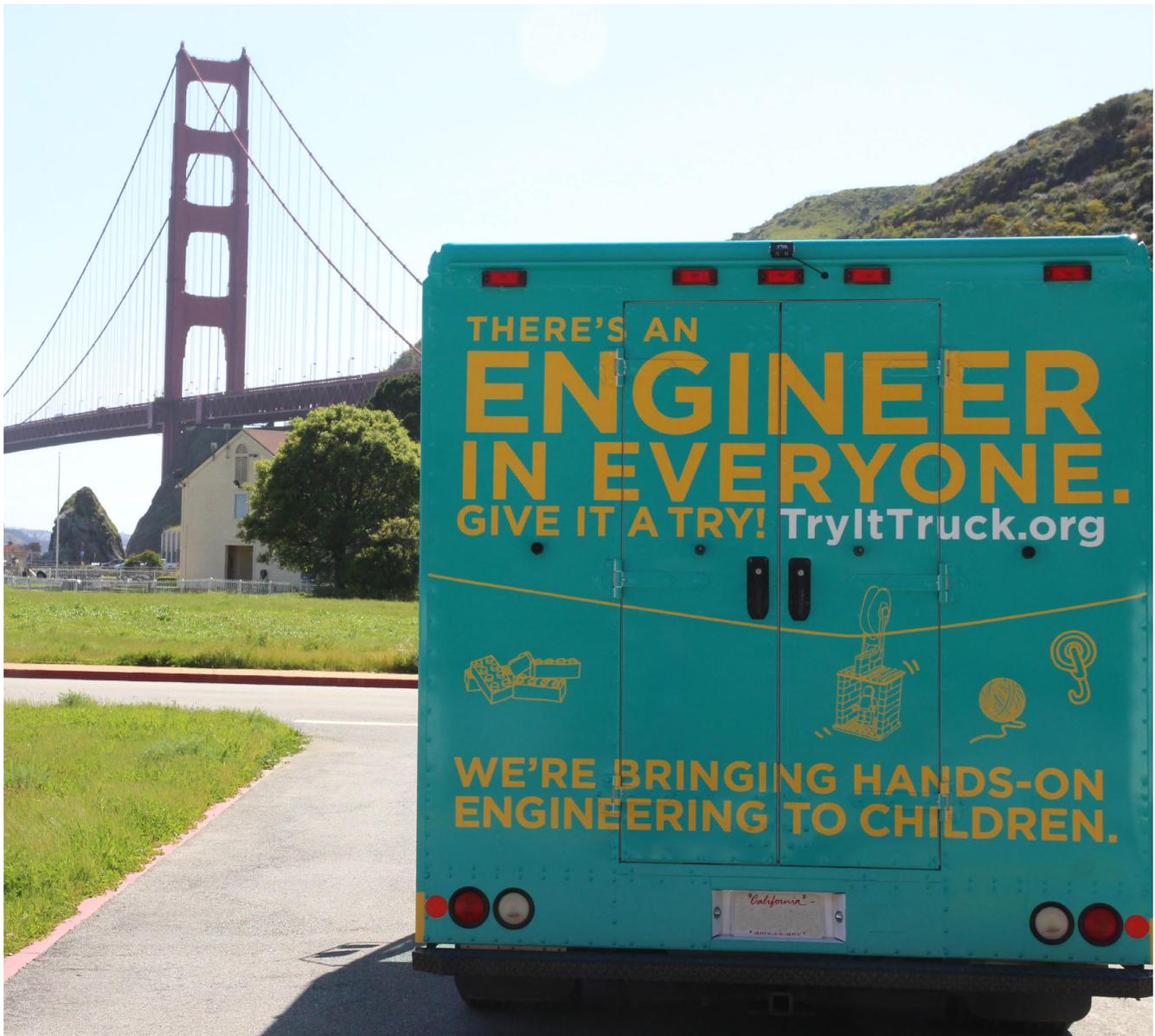
- Using real tools, such as hammers, screwdrivers, and rasps was very exciting for students and adults of all ages, even when one of our BADM staff educators was not able to directly engage with children at one of these stations. However, the high-tech tools, such as the laser cutter, 3-D printer, and tablets with digital design software, were only accessible and exciting when one of our staff was able to facilitate the activities and scaffold the process. **Going Forward:** We will continue to explore the use of high-tech tools with both the Try It Truck and our Fab Lab to understand and improve student engagement.
- We differentiated program content and facilitation by grade level groups, so all children in grades K – 2 and those in grades 3 – 5 experienced the same programming. This was particularly effective in our one-day Engineering Extravaganza program since these programs were child-directed and easier to tailor via facilitation style and vocabulary. **Going Forward:** We will further differentiate our three-day Engineering Intensive programs so that children receive STEM content knowledge more specific to the NGSS standards for their individual grade levels. We will also provide access to different tools, such as hot glue guns and hand saws, for older students in grades 3 – 5 in order to increase the rigor of their engineering challenges.
- While we did differentiate programming by grade level so that it would be developmentally appropriate for all students, we found that younger students in grades K – 2 still struggled with components of the multi-day program. We realized that it was not enough to only change the STEM content of the multi-day program for younger students but that it was hard to engage these students in learning both a new engineering design process and several new high- or low-tech tools at the same time. **Going Forward:** We are further differentiating the multi-day programs for younger students by structuring the experience so that children solve a different engineering challenge each day and are introduced to only one tool (either high- or low-tech) each day. This will give us the space to provide more support for younger students as they experiment with a variety of tools. For students in grades 3-5, we will continue with the multi-day program structure we piloted in the spring.
- Prior to the program, teachers said it would be helpful to provide more pre-visit curricular resources around vocabulary and technical terms that children may encounter during the program. As one pilot partner teacher noted, “One tip: for the intro piece, using even more visuals since most of our students are English Language Learners is helpful (i.e., when talking about a station, hold up some of the items as you name them or hold up a paper with their name on them too.)” **Going Forward:** We plan to provide a book list that previews vocabulary as well as videos of some of our high- and low-tech tools in action.

Key Takeaways of Try and Retry Phase

- 1. Always have a plan B.** Whether it is a rain plan or low-tech variation of a high-tech activity, it is important to build contingency plans. Often wifi wasn't available or a high-tech tool had a software glitch or traffic delayed our arrival. All of these things are to be expected and shouldn't get you rattled.
- 2. Clarify expectations.** When parents, chaperones, administrators, and staff know what to expect before, during, and after the program, they can participate more fully and free of anxiety. We are continuing to iterate on the various forms, emails, and letters that make our expectations clear and concise.
- 3. Make time for immediate feedback.** Some of the most useful feedback we received was when we asked a teacher, child, or chaperone about their experience right after the program was finished. Even though the day is long, taking a few minutes to jot down notes in an organized way immediately after a program ends will pay off in the long run and allow for rapid prototyping.
- 4. Ask for volunteers.** Don't be afraid to ask for volunteers and to put teachers, chaperones, and even children to work in the setup, cleanup, and facilitation. We were pleasantly surprised by the number of helping hands that were eager and excited to dive in.
- 5. Break it down.** There are many things you could test with each program (i.e., How far should we travel? How many staff are needed? What high- or low-tech tools work for which situation?). It is important to break down the large questions you want to answer about your program into smaller pieces that you can focus on for each pilot test. This allows you to rapid prototype by identifying and incorporating small and large changes as the program develops.

Looking Ahead

During our 20 days of pilot programming, we drove over 1,000 miles, visited six different counties, and worked with 45 elementary school teachers and 1,200 students in kindergarten through fifth grade. Upon completion, we quickly turned our attention to synthesizing all of the feedback to make changes for the 2017/2018 school year. While doing so, we also embarked on a second pilot program with 10 libraries throughout the Bay Area. We are currently assessing the results of library pilots in order to be able to serve children and families outside of school as well. Our goal over the next three years is to continue to revise and expand our program offerings and expand our services to include schools, libraries, and community organizations throughout the area.



For news and updates on the Try It Truck, visit TryItTruck.org and follow the Bay Area Discovery Museum on Facebook, Twitter, and Instagram. And don't forget, The Try It Truck is now available for educators to book it to come to their school, library, or community center in the greater Bay Area. Online registration is open at TryItTruck.org.

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